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ANCIENT JEWELRY.

BY WILLIAM DUTHIE.

(*With a Coloured Plate.*)

ANTIQUARIANS, acute, learned, and indefatigable, have taken such pains to describe, among other ancient remains, the specimens of Egyptian jewelry which have been discovered in recent times, that it might appear unnecessary to treat of them further. After the elaborate explanations of Prisse d'Avennes, Daly, Sir Gardiner Wilkinson, Dr. Birch, and others, of Egyptian ornaments, and the voluminous account given by Mr. Layard of Assyrian antiquities, there might appear to be a certain presumption in any attempt to enlarge upon a subject which had been already so amply and so ably treated.

But, however carefully these ancient and interesting relics may have been described in an archæological point of view, they have never yet been dealt with in a practical way as pieces of workmanship; and it is in this light it is purposed to consider them here. It is evident that, so considered, they offer a very interesting field, not merely for speculation, but for the accumulation of proofs directly tending to show the progress made in the finer mechanical processes of art-workmanship in those early ages. To a workman, testing them by his own special knowledge, they may give evidence of a character different from, and not less interesting than, that offered to the antiquarian and the philosopher.

Acting upon this idea, the pieces of jewelry in the Coloured Plate have been selected as much for the purpose of illustrating certain points of workmanship, as for their marked character and beauty; to show, in fact, what advance the Egyptians and Assyrians had made in the arts of casting, chasing, soldering, stone-cutting, and other more technical processes in the manufacture of personal ornaments. It is believed that the objects chosen have not hitherto been engraved, and these

are represented in some cases in the state in which they were worn, instead of in their present dilapidated condition. With the exception of No. 1, an earring reduced from many examples of the same ornament on the colossal figures of the Assyrian bas-reliefs, the specimens shown are to be found in the cases of the British Museum. The very curious and beautiful collection of relics discovered at Thebes, and exhibited by the Pasha of Egypt at the English International Exhibition of 1862, would not have served the writer's purpose equally well, the majority of them not coming within the category of jewelry, being testimonial pieces, or symbols of office. These relics have been fully explained by Dr. Birch, and carefully copied and illuminated by Mr. Kiddle, of the War Office.* They are, it is believed, the most ancient specimens of art-workmanship in the precious metals in existence, dating from about B.C. 1800, or 3600 years ago. They will be again referred to.

It is surprising how far into the inner life of a people an examination of the works under review may lead; for the existence of one fact, proved to demonstration by the work itself, helps to establish other facts not so patent, and to suggest consequences of great interest, and of the utmost importance in determining the condition of art-manufacture at the period referred to. When, in opening some ancient British tumulus, the antiquarian unearths a rude ornament of gold, probably the breast or neck decoration of a chief, and finds it to consist of a simple thin plate, beaten into something like shape to serve its important purpose; having no mark of chasing-tool or graver, and, above all, no union by solder of two parts together, he must inevitably come to the conclusion that the goldsmith's art, at the time the ornament was made, must have been in the most primitive condition. It must be at once evident that here is simply a piece of hammer-work, in the making of which little taste and less skill have been exerted. On the other hand, every little addition to the naked piece of metal is not only a proof of a higher state of art in itself, but is evidence of progress in other directions of a kindred nature. Even so small a thing as a piece of wire is a sign of a decided advance in art upon the original crude plate; and, moreover, it shows progress in mechanical appliances; for the production of a piece of wire implies the possession of tools of an exact and complex character. Examined in this way, the process of manufacture of a simple piece of jewelry will serve to show the existence of other arts than that of the goldsmith.

* *Fac-similes of the Egyptian Relics Discovered at Thebes*, 4to, London, 1863.

The same antiquity cannot be claimed for the specimens chosen for illustration as for the relics of Queen Aah-hept; but the most recent example is of about the year B.C. 300. The Assyrian earrings, Nos. 1 and 5, are from Kouyunjik (Nineveh), of about 700 years before Christ. The necklace, No. 2, and the earrings, Nos. 4 and 7, are from Babylon, of probably a somewhat later date. The ring, No. 3, representing the figures of Serapis, Isis, and Horus, is of the Ptolemaic period, about B.C. 300 years. The bracelet, No. 8, is inscribed with the name of Namrut (Nimrod), an Egyptian prince of the twenty-second dynasty, from Sais, and therefore dates from about 500 years before Christ. The numbering has been arranged on the principle of taking the most simple forms and workmanship first, having some regard also to age.

The earring, No. 1, although not actually existing as a gold specimen, is found so repeatedly on the colossal bas-reliefs of the Nimrod collection, that it may be taken as a very common type of ornament, and although certainly elegant in form, is of very simple construction. It may have been cast solid, or struck with a punch in two pieces, and soldered together. It is scarcely probable that it was cast solid, as in that case its excessive weight would render it painful and even unsafe to wear. That the Assyrians certainly, and probably the Egyptians also, were in the habit of casting ornaments in metal, we have distinct evidence in the ring moulds discovered by Mr. Layard, and exhibited in the Nineveh collection. Not only have we there a mould for casting rings—not a mould of sand, as used in modern times, but of some chalky or clayey substance, in which the subject is cut in both halves of the mould, with a proper gate wherein to pour the melted metal, and radiating lines to admit of the escape of the air—but also small bells and weights, on which the distinct ridge left by the juncture of the mould is still visible. But even for so rude a piece of jewelry as a cast earring, some mechanical appliances are necessary beyond the mould and the metal. Some sort of furnace must have been erected, with probably wood for fuel, and an inflated pig-skin for a bellows. The workman must also have had crucibles, and some kind of iron pincers to lift his gold out of the fire.

But it is more probable that the earring in question was hollow—struck by means of a punch in two halves, and soldered together. This is undoubtedly the method pursued in the manufacture of the chain, No. 2; and adopting this conclusion, we must pre-suppose the carving or moulding of iron or bronze punches, and the knowledge of the several delicate operations which go to complete a soldered juncture of metals. We have no difficulty in determining the fact of the use of

carved punches in the manufacture of jewelry, for there are abundant evidences of it in the necklaces and other ornaments which are exhibited in the British Museum. One necklace of shells and cornucopiæ, placed alternately, is especially remarkable. It is of silver, and each kind of ornament is so exactly similar, that they must necessarily have been struck off the same punch. A bead necklace offers the same evidence; and it is not at all improbable that many of the aphes, cobras, scarabæi, and other symbolical ornaments which we find embedded in opaque glass, were struck from carved punches out of thin gold plate. The question then arises, how were these punches made? Were they also cast in moulds, say in bronze? Or were they forged, and worked up by file and graver into the required form? We have no evidence of the existence of a file at this period; and a file, besides that it must be of steel to be of any service, even upon bronze, is a really artistic production. There is no proof that steel was known at so remote a date, and the probabilities are against such a supposition. Cast iron is a modern invention; and regarding the matter from all sides, one is almost forced to the conclusion that these punches were cast in bronze, and finished for use by such cutting gravers or other tools as sharpened iron would furnish. The suggestion that these exactly similar ornaments might have been struck in dies offers many difficulties, for a die is an implement of manufacture much more difficult of production than a hand-punch.

Then arises the question of soldering. These duplicate pieces, struck with a punch, and made of an equal height by being snipped round their edges with shears, and rubbed down on a stone, must now be united by solder—not mere tin or pewter, but what is technically known as *hard* solder, *i.e.*, a metal only so far inferior by the addition of alloy to the metal it is to unite, that it is fusible at a somewhat lower degree of heat. But to solder in this way requires tools and appliances of a more delicate nature than we have as yet had to deal with. The preparation of solder itself, with its careful and minute proportioning of alloy, and its no less careful fusion—its thinning into plate, and its reduction by some means, by shears or by file, into small particles for use—requires considerable skill and indispensable tools. Then it is impossible to solder without some species of flux, to prevent the oxidation of the two surfaces to be united, during the process. What flux had the Egyptians or the Assyrians? It is a fact that in many parts of the East Indies to this day the native jewelry, although admirable in many points of execution, is not soldered together, but dovetailed, in a manner of speaking, by a series of minute "spitzens." The fineness of the gold employed admits of

this process, and the work does not depend for its strength upon its connected parts. The setting of their gems is invariably effected in this way, and with a little force may be lifted off bodily.

Borax is the immemorial flux of the jeweler all over the world, and it is not at all improbable that the Egyptians possessed this valuable medium; especially as, although now an artificial compound of its element, boracic acid and soda, manufactured to meet the demands of commerce, it is found, and was to be found doubtless in that remote time, as a natural production. But given the borax, the solder, the shears, or the file, we still require the charcoal, or some equivalent for it; and what is more, we still require the blow-pipe. His inflated pig-skin would not serve the Assyrian here; something more manageable was necessary—something which possessed both force and precision. It is held by scholars that Pliny (the younger) speaks of borax under the title of *chrysocolla*, and it is not at all unreasonable to suppose that borax, under this or some other name, was known at a much earlier date than his time. If the Egyptians had not discovered charcoal—and it is very possible they had, considering their necessarily constant use of wood—it would not be difficult to find some light porous stone to answer its purpose;* and the origin of the blow-pipe is so involved in obscurity, that there is scarcely any date too early to fix for its discovery. Moreover, although the blow-pipe of the modern chemist is a very scientific implement, it must be remembered that the jeweler's blow-pipe to this day is simply a piece of bent tubing, smaller at one end than the other. It is at least certain, then, that to solder, the ancients must have possessed some knowledge of alloy, and had for tools the blow-pipe, shears, or files, charcoal, or some analogous non-conductive substance, and must have known the valuable uses of borax as a flux.

This question of alloys is of more consequence than may at first sight appear; for, as a rule, the gold used in these ancient ornaments was in nearly a pure state; and it is not unreasonable to suppose that a knowledge of the ready fusion of certain other metals therewith might have tempted the workmen of antiquity to deteriorate the precious metal, as is systematically done in modern times. The universal use of fine gold suggests also one other solution of the solder difficulty: it is that fine gold, and fine gold alone, may, by the help of a flux, be "sweated," or brazed together instead of soldered; but it is a careful process, and can only be done with heavy pieces of work. It is true there are some examples of framework for

* Lava is an excellent substitute, but not likely to be found among the sands of Egypt.

inlaying in the cases of the British Museum which have a suspicious aspect, scarcely compatible with purity of material, but they are the exception to the rule; and, on the other hand, it is certain that many legitimate uses, of a less pure but harder gold, were altogether unknown. Thus, there are no joints to earrings, or spring fastenings to any of the ancient ornaments. The earloops are simply the attenuated ends of fine gold wires, which, once passed through the ear, were bent round till they held in their places, to be again straightened, should the earring require to be removed—a thing, it may be presumed, not often done. The bracelets, again, are permanent ornaments, and could scarcely have been removed without the aid of the jeweler.

No. 3 is a copy of a ring of the Ptolemaic period, and is made of woven wire, from which spring three cast and chased figures of Serapis, Isis, and Horus. Although generally effective, the workmanship of this ring is exceedingly coarse. It may be here remarked that nothing is so general as the introduction of chasing in all Egyptian jewelry, and indeed in all their metal work. There are even frequent examples of attempts at embossing, or *repoussé* work. This chasing, as a rule, is very rude, and consists of little more than outlines, but there are cases in which it is much more finished, and indeed very effective. The claw of a hawk in one of the upper cases of the Mummy Room of the British Museum is an example in point. The earring, No. 4, a relic of Babylon, is one specimen of modelling, casting, and chasing, although by no means one of a high order; and the Assyrian earring, No. 5, discovered by Mr. Layard at Kouyunjik (Nineveh), and which has a pearl at each end, is, no doubt, chased all round, and chased after the present method; that is to say, by being first filled with bituminous matter, in order to offer a sufficient resistance, and no more, to the blow of the chasing tool and hammer. The bitumen, resin, or gum with which the earring is now filled is probably an after arrangement, and in this respect it is similar to the loaded jewelry made even down to the present day in the East Indies. The earloop is conjectural, as the original one is lost.

The cylinder seal-ring, No. 6, is an admirable example of a type common among the Egyptians, and shows well the very general use among them of thin wire-work. Wire was made to serve as ornaments on plain surfaces in very many cases, and in its then use may fairly be taken as the origin of filagree, to which, in some instances, it bears a resemblance. The great use of wire is a fact to be noted, for the manufacture of this gold thread is by no means a simple process. It could not have been produced by mere hand labour, and must have

been drawn then, as now, through a graduated series of holes, made in some much harder substance than itself. Indeed, it seems difficult to conceive of a wire draw-plate in any less durable and compact metal than steel. A mere rude hole in a piece of iron would not answer the purpose, as it would rip and break the metal—the more so with so soft a metal as fine gold—and at the best would only produce wire of its own shape. A wire draw-plate is a very exact piece of workmanship, in which the holes are carefully graduated in size, so as not to produce too great a strain upon the metal at one time, and brightly polished so as to cause as little friction as possible, as well as to produce a wire of a perfectly round and smooth surface. Even when made of the finest steel, such plates wear rapidly, and the modern improvement is to substitute an eyelet of sapphire, or similar hard gem, in which the hole is made, instead of in the bare metal. Notwithstanding these difficulties, we must suppose that the Egyptians possessed some more or less perfect wire draw-plates, and, in addition, the vice and draw-plyers, in some shape or other, without which the first would be useless.

The consideration of the earring, No. 7, and the bracelet, No. 8, has been reserved to the last, because they present features of a character very different to the other examples.

The earring, which is from Babylon, is, to judge from its elaborate character, the most recent production of any here shown. It is not without a certain beauty of form, and is peculiar in the number of pieces of which it is composed, and in the fact that it is a "mounted" piece of work. Its component parts are neither cast nor struck with a punch, but made up in pieces from thin plate, soldered together, and filled with gum. It is made, in fact, in the same way as it would be made at the present day, with the exception of the gum; and could only be executed by a skilful hand with the aid of small round and flat plyers. Here, again, we are forced to the belief that such tools were known to the Babylonians at least, if not to the Egyptians. The lozenge-shaped stones are inlaid and flat, supported by the gum; the others are cut *cabochon*. The bracelet, although apparently a complicated piece of workmanship, is in reality very simple; and this again is "mounted" out of thin flat plate and chaneer, *i. e.*, hollow wire. Its great peculiarity is that it is jointed. The skill required, and the tools necessary for the drawing of wire, has already been dwelt upon, but the difficulty of making hollow wire from flat plate is even greater. Yet this is no new feature in Egyptian jewelry, for among the relics of Queen Aah-hept, B.C. 1800, 3600 years ago, is a bracelet having a joint containing fifteen divisions, technically called "knuckles;"

that is to say, seven divisions fitting into eight, like a well-made modern snuff-box. In both these bracelets there are two joints, and they are placed just so wide apart as to admit of the passage of the wrist, when the pin was again passed into the open joint, and the bracelet, or rather armlet, thus became permanently fastened.

There remain still two points to be considered; the manufacture of gold plate and the process of inlaying, of which latter art both the last described earring and the bracelet are good examples. It is difficult to understand how the gold plate, of which the Egyptians made so great a use, can have been produced, without the aid of some machinery of the nature of the flatting-mill of the present day. It is certainly possible to hammer fine gold into a thin sheet, but this can only be done by placing it between vellum, or some similar substance, and subjecting it to heavy blows by the hour. On the naked anvil it would be scarcely possible to produce an even surface, and then only by means of finely-polished steel hammers, which the ancients can scarcely have possessed. Yet it is easier to believe that they hammered their gold into plate on the anvil than that they possessed so complicated as machine as a rolling or flatting-mill.

As to the inlaying, Dr. Birch tells us, speaking of the relics of Queen Aah-hept, that "they are encrusted in a kind of *cloisonné* of opaque glass of blue and red colour, and are not enamelled. This latter class of work not being known prior to the Roman Empire." Again: "the principal substances used for this purpose by the Egyptians were lapis-lazuli, root of emerald, or green felspar, jasper, obsidian, and opaque glasses imitating them, and the delicate blue of the turquoise."

The bracelet before us appears to have been inlaid mainly with lapis-lazuli, alternating with thin plates of gold, also inlaid, and altogether representing that peculiar zigzag which was employed by the Egyptians to represent running water. The present drawing has been taken from the side, instead of the front, of the bracelet, in order to represent this more fully. The question now arises, by what means did the ancients cut their precious stones and coloured glasses into the required shapes? We know they were expert engravers on stone, but it is hardly to be supposed that they had invented the lathe, and engraved their figures and inscription by means of the points and small disks of the modern seal-engraver. Yet something of this kind they must have done; for, assuming that their seal-devices and writings were cut by small chisels, or by friction with the points of harder stones, which is possible, but extremely laborious, how could they have shaped their seal-stones for setting or for inscription without a lapi-

dary's mill? Even more necessary would such an implement be for the purposes of inlaying; for granting that the Egyptian or Assyrian workmen were able, by some rude means, to fit their separate pieces of mosaic into the places prepared for them, how would they level the whole surface, as they have undoubtedly done, smoothing it and polishing it to a high degree, without the action of some machine, revolving with rapidity, which should make a clean sweep of it?

It is impossible to answer these questions. The utmost we can do is to make careful guesses from visible facts. It may be said that it was quite possible for the ancients to effect all they did in the manufacture of jewelry without any of the tools of the modern art workman, given the requisite time and patience. Doubtless, this is one solution of the difficulty; for we know from later works, executed under difficult circumstances by prisoners and others, that it is almost impossible to impose too hard a task on the ingenuity and perseverance of man. But then, in such cases, time and labour must count for next to nothing.

Whatever the implements at his command, it is clearly evident that the Egyptian and the Assyrian workman could melt and alloy the precious metals; could flatten them into thin plate, draw them into fine wire, prepare punches to strike them into ornamental shapes, and solder these shapes together. Further, that he could chase and engrave; that he could "mount" the metal he had prepared into any form his taste might suggest, and could inlay his mounted work with coloured glasses and stones. Also, that he could make moulds, and cast solid ornaments, could gild metal, and weave wire-chains. Lastly, that he could cut, engrave, and polish the hardest stones; could set them in rings and as amulets; and that his taste had in it so much of vitality that it lives and inspires his successors even to this hour. In fact, we may deny this ancient craftsman the possession of many tools which appear to us indispensable at the present day, to effect the same object, but in doing so we only acknowledge, and must the more admire, his skill and his perseverance.

TRIAL OF THE PYX.

In the days of our remote ancestry, when mints existed in different parts of Great Britain, and were superintended by various individuals known as moneyers, it was no doubt necessary that frequent examinations of the various coins issued from those establishments should take place. Such examinations constituted valuable checks upon those who were engaged in the manufacture of the State monies, and were a guarantee to the public that those monies were of the legal standards of weight and of fineness. For many centuries, however, trials of the Pyx took place within the mints themselves, and were conducted by officials connected with the mints. They were made at stated intervals, usually once in every three months, and they came to be considered part and parcel of mint duties. It is not essential for our present purpose to inquire into the mode of operation pursued in those primitive days of English minting, and, if it were attempted, the task would prove to be one of extreme difficulty, from the fact that the sources of information are few and unsatisfactory. We may, therefore, more profitably consider the subject of the trial of the Pyx from the period when, according to the best historical data, it became a public ceremony, and when our monarchs not unfrequently took part in it. Ruding, in his elaborate and erudite work known as the *Annals of the Coinage of Great Britain and its Dependencies*, fixes this time very precisely, for he states that the first public trial occurred on the 24th February, 1248, the 32nd year of Henry III., before the Barons of the Exchequer, the jury being composed of twelve discreet and lawful citizens of London, with twelve skilful goldsmiths of the same place. The first known writ for such a trial is dated, nevertheless, at a later period, namely, 1281, and, in the reign of Edward I., and it is pretty clear that the trial of the Pyx,* or Mint-box, as now practised, and as against the Master of the Mint, was really instituted in the year last named. It was certainly not till 1279 that the royal mints were consolidated under one mint master, and that the latter became party to an agreement with the king (Edward I.) for the execution of the coinage of the realm, and thus made himself individually responsible for its genuineness. An ordinance was passed in the same year called Rotulus de Monetâ, or the Roll of the Mint, and intended to regulate the proceedings there. A copy of this ordinance exists, and it ordains: 1. That a standard should be made and kept at the Exchequer, or where the king wished, and that the coin should

* Derived from the Greek Πυξις, a box.

be made according to the standard of identical goodness. (Premeurement qe hom doit fere un estandart qe doit demorer al Eschekar, ou en quel lieu qe nostre Seignor le Roy vodra. Et selone la forme del estandart serra fete la moneye, et de tiel bonte come lestantar). In the sixth clause of the Ordinance reference is distinctly made to a Pyx-box, in which was to be deposited a sterling coin out of every ten pounds weight struck for the purpose of making the assay or trial. It also gives explicit instructions as to the custody of the keys of the box, of which there were to be two, one for the Master, and one for the Warden of the Mint.

The system of holding trials of the Pyx, obtained with more or less regularity, once in three months, until the reign of Queen Elizabeth, and Ruding quotes the following from an account of such proceedings which took place in her reign—"And uppon reasonable warning thereof given, it (the Pyx-box) shall be op'ned once in three monnethes before some of the Queen's Counsell assigned, in the presence of the said Warden and Master; and ther shalbe maid assaies as well of the finness as of the waight of the said monies of gold and silver by enie meannes in the said box."

Pending the troublous times of Charles I., trials of the Pyx were held at very irregular and uncertain periods, the probability being that they were deemed of much less consequence than the trials of strength continually waged between that unhappy sovereign and his parliamentary antagonists.

During the Commonwealth it is believed that only one public examination of the coinage took place, and that a long time after Cromwell's accession to supreme power, namely, in 1657. The warrant for this is still extant, and, since, it is very brief, it may not be uninteresting to quote it entire. It runs as follows:—

"Oliver P.

"Whereas, amongst other weighty affairs of the Commonwealth, the care of assaying and trying the monies thereof by the standard of England, according to the ancient custom of the realm, is not the least. We, judging it necessary that the trial and assay of the said money be forthwith made, do therefore hereby signify such our will and pleasure to be, commanding you forthwith to cause a trial and assay to be made of the Pyx, now being in the Mint, within the Tower of London, by a Jury of Goldsmiths of our said City of London, of integrity and experience, to be empannelled on a day certain to be by you in that behalf appointed, in the place accustomed, within our Palace of Westminster, and that the Lords Commissioners of our Treasury, the Justices of the several Benches, and Barons of the Exchequer, or some of them, be then there present and

counselling and assisting you in the execution of our service."

"Given at Whitehall, the 9th day of November, 1657.

"To our trusty and well-beloved Nath. Fiennes and John Lister, Lords Commissioners of our Great Seal of England."

From the period of the Restoration to the time of Her Majesty Queen Victoria, trials of the Pyx have occurred at very uncertain intervals, generally, however, on the appointment of a new Master of the Mint* the ceremony is performed, it being held desirable to relieve the retiring officer of all responsibility, and to transfer it to his successor. No other specific rule exists either on the authority of a Royal Warrant or an Act of Parliament for regulating the time when such trials shall take place. The practice, however, of late years has been to determine this point by the contents of the Pyx-boxes themselves. When those receptacles become filled with coin, it is physically essential that they should be emptied, and, in order to accomplish this feat, the cumbrous machinery of the State has to be put in motion.

There are two Pyx-boxes deposited in a strong room at the Mint, and the rapidity, or otherwise, with which they are charged, depends on the activity of the stamping presses of the establishment. One of the boxes is for the receipt of gold and the other of silver coin. Each of the boxes is furnished with three distinct locks, and the keys of which are retained respectively by the Master, the Deputy Master and Comptroller, and the Queen's Assay Master. In the boxes a single coin from every journey weight† of gold or silver money transferred to the Mint office from the coining department is deposited. At the close of each day's weighing of coins at the central office of receipt and delivery, the Pyx coins, corresponding in number with that of the journeys passed through the scales, are put up in a paper parcel, and sealed by at least two of the officers just mentioned. They are then placed in their sacred prisons, and securely locked up until the day of trial. It may be stated, in passing, that other pieces are retained day by day from the current work, and tested both as to weight and fineness by the Deputy Master and the Assayer. These operations are known as the Mint Pyx Assay, and they are always completed before the bulk of coin to which the trial pieces pertain are forwarded to the Bank of England.

* The office is now held as a life appointment, and has been so held since 1851. Formerly it was a ministerial post.

† A "journey" of gold consists of 180 ounces, or 701 pieces (sovs.), and a journey of silver of 720 ounces, the number of pieces being dependant on the denomination of coin. The word journey is believed to be a corruption of the French word *journèe*.

Whilst treating of this part of our subject, it will not be out of place to mention that each pound troy of gold is coined into 46$\frac{4}{6}$ sovereigns, and that the standard degree of fineness of the coin is twenty-two carat, that is, twenty-two parts fine gold and two parts of alloy, in accordance with the Act 56 Geo. 3, c. 68, s. 11. The pound weight of silver is coined into 66 shillings, the same rate being observed with all other denominations of silver money, its standard degree of fineness being eleven ounces two pennyweights of fine silver, and eighteen pennyweights of alloy, in pursuance of section 4 of the same Act of Parliament.

Having thus explained, with, it is hoped, as much distinctness as will make the arrangements intelligible, the mode of charging the Mint Pyx-boxes, let us proceed to detail the ceremonial processes intermittently practised for the discharge of their precious contents.

The repletion of the boxes being officially made known by memorial to the Treasury, the Chancellor of the Exchequer moves Her Majesty in Council, and an Order in Council, appointing an early day for the trial of the Pyx, is the result of this action. The Chancellor of the Exchequer also issues his warrant to the Comptroller General of the Exchequer, directing that officer to produce, at the specified date, the standard trial plates* and standard weights in the custody of the Exchequer office. Immediately before the trial the Pyx chamber is formally opened by officers of the Treasury and Exchequer, and the plates, removed from their sealed depositories, are forthwith curtailed to a slight extent of their fair proportions, the cuttings being reserved for assay in the manner presently to be mentioned.

Simultaneously with these proceedings, notice is given by the Treasury to the Lord Chancellor and to the Queen's Remembrancer of the day of trial. The great law officer next issues a precept to his loving friends the Wardens of the Mystery of Goldsmiths of the City of London, and requiring them to nominate a jury of sufficient and able freemen of the company, "skilful to judge of and present the faults of the coins, if any be found," and to be present at the day and hour appointed for their trial.

When the fell moment has arrived, the various persons whose duty it is to sit in judgment upon the imprisoned coins assemble at the office of the Comptroller General of the Exchequer, in a room appointed for that purpose; those persons, according to a recently published official paper, to which further reference will have to be made presently, comprise

* For full description of standard plates, *vide* INTELLECTUAL OBSERVER, vol. vi., page 82.

"Certain members of the Privy Council, who constitute the Court, with the Lord Chancellor for president; the Comptroller General and other officers of the Exchequer, the Serjeant-at-Arms attending the Great Seal, the Queen's Remembrancer and his officers, the Master of the Mint, the Queen's Assay Master, and other officers of the Mint, the jury, freemen of the Goldsmiths' Company, including in their number their Assay Master, together with the Clerk of the Goldsmiths' Company and their attendants." A goodly array of authorities, and no doubt the Serjeant-at-Arms attends with a view to the capture of the Master of the Mint, who is also on his trial, should the jury find an adverse verdict, and declare that the Pyx coins are below legal standard.

The oath is next administered, and it is as follows: "You shall well and truly, after your knowledge and discretion, make the assays of these coins of gold and silver, and truly report if the said monies be in weight and fineness according to the Queen's standard in her Treasury for coins; and also if the same monies be sufficient in alloy, and according to the covenants comprised in an indenture thereof bearing date the 6th February, 1817, and made between His Majesty King George III., of the one part, and the Right Hon. William Wellesley Pole, of the other part. So help you God." After the foreman of the jury has duly taken this oath, and "kissed the book," it is administered to his fellows in batches of three or four at a time. Then the work of examination is really about to commence, and the jury return to Goldsmiths' Hall, having in their custody the portions of the gold and silver plates before named. The Pyx-boxes of the Mint have already reached that place, and the first work of the jurors is to count out and weigh their contents. They then select from the whole mass of coin a certain number of pieces of each denomination, and melt them in the ordinary way into ingots of gold and silver. From the corner of each ingot a small piece is cut off, and then the ingots themselves are flattened by hammering and lamination into straps or bands of about $\frac{1}{30}$ of an inch in thickness. From the straps pieces are punched and weighed with the closest accuracy. The cuttings are put into paper envelopes, upon which their respective weights are noted to the one-thousandth part of a grain. Then follows the assay, which is effected by "cupellation."* Other jurors busy themselves with the test plate slips and cuttings, and effect *their* assay by precisely analogous means. Finally, reports are made by the two sets of operators—the proceedings

* *Cupellation* is the art of refining gold or silver by means of a cupel, which is a small vessel that absorbs metallic bodies when changed by heat into fluid. The operation is explained at length in all encyclopædias of science.

lasting several hours—and those reports are compared. To the credit of the Mint, it must be said that the jurors' reports have seldom or never disagreed to an illegal extent, certainly they have not since the year 1290, and, consequently, no Mint Master has ever, from such a cause at least, been carried off by a Serjeant-at-Arms.

The true standards of weight and of fineness of all gold and silver coins issued from the Royal Mint have been already mentioned, but it must be observed that a certain amount of latitude is allowed by law in both those respects. It has been found practically impossible to manufacture metallic money in large quantities, and with any degree of rapidity, in such a way as to insure the perfect uniformity of each individual coin with the exact and true theoretical standard prescribed. In spite of the most rigid attention in the admixture of the alloy with fine gold or fine silver, there will occur deviations in the ultimate degree of fineness of different parts of the resulting metal. So, again, with regard to weight. However mathematically precise the mechanism necessary for the production of coin may be in its action, there is sure to arise variations in the weight of the planchets cut out for stamping. This latter result arises mainly from the differing density of the metal operated upon. Legal allowance is made for these inevitable aberrations, from which even the trial plates are perhaps not entirely exempt. This allowance is termed in the Mint indenture the "Master's remedy." This remedy has varied in extent at certain periods, but at this moment is, so far as gold is concerned, $\frac{1}{24}$ of a carat, or twelve grains upon each pound troy, both as respects fineness and weight. The remedy allowed upon silver employed in the coinage is one pennyweight per pound troy, for the standards both of weight and fineness. Beyond these limits it may be said to be impossible for any Mint coin of gold or silver to escape the Mint walls. The trial of the Pyx is supposed to demonstrate this fact, and to give it the stamp of extra moral, and independent official certainty.

We may now give some particulars as to the most recent public trial of the Pyx, with the finding of the jury on that occasion. The trial took place on the 19th of January of the past year, and was conducted precisely in the way indicated above. The monies thus examined comprised Pyx-pieces, culled as described from the daily productions of gold and silver coin at the Mint between the first day of January, 1861, and the 31st day of December, 1865, both days inclusive. The jury, at the close of their investigation, stated that they found in, and took out of the Pyx-box, gold coins consisting of 45,482 sovereigns, or twenty shilling pieces, and 4348

half-sovereigns, or ten shilling pieces, coined after the rate of £46 14*s.* 6*d.* (or £46·725) to the pound weight troy, making, by tale, £47,656, and weighing 12,239·713 ounces; but which, at the rate of £46 14*s.* 6*d.* (£46·725) to the pound weight troy, should weigh 12,239·102 ounces; and, having taken 224 of the said sovereigns, and 39 of the said half-sovereigns, being in tale £243 10*s.* (or £243·500), and in weight 62·533 ounces, did find the same to be, by the assays and trial thereof, agreeable to the standard trial plate of gold in Her Majesty's Exchequer, dated the 31st day of October, 1829. The *precise* results of the inquiry may be summarized as follows: The Pyx gold monies amounted by tale to £47,656, and by the theoretically true standard should have weighed 12,239·102 ounces; they were really found to weigh 12,239·713 ounces, being in excess 0·611 ounces. The aggregate allowance for this quantity of coin is 25·498 ounces, either above or below the standard weight, and it is seen, therefore, that the Pyx pieces were within remedy to the extent of 24·887 ounces, or 2·396 per cent. of the deviations allowed.

With regard to the silver coin so tested, the jury reported that they found in, and took out of the Pyx-box 2936 florins, 3367 shillings, 1006 sixpences, 10 fourpences, 545 threepences, 10 twopences, 10 threehalfpences (circulating in the West Indies), and 30 penny pieces (Maunday money), coined after the rate of 66 shillings to the pound weight troy, and making by tale £494 7*s.*, and weighing 1796·943 ounces, but which, at the rate named, should weigh 1797·637 ounces; and, having taken of the said silver coins 42 florins, 60 shillings, 2 fourpences, 26 threepences, 1 twopenny piece (Maunday), 4 threehalfpenny pieces, and 2 pennies, being in tale £8 7*s.* (or £8·350), and the weight, 30·363 ounces, did find the same to be, by the assays and trials thereof, agreeable to the standard trial plate of silver in Her Majesty's Exchequer. The remedy on such a quantity of coin is 7·490 ounces, but, as their lack of the true weight was only 0·694 ounces, it follows that the silver Pyx was within legal allowance to the extent of 6·796 ounces. The foregoing verdict, accompanied by certain ancient verbiage, here purposely omitted, having been delivered, the business proceedings of the day terminated, the trial plates were deposited in the cloisters of Westminster, and the Pyx-boxes were returned to the Mint, there to remain until the next trial of the Pyx.

The court and jury had a pleasant duty to perform in the evening, for they then partook of a sumptuous banquet in the magnificent Hall of the Goldsmiths' Company, a practice which of late years has been regularly adhered to on similar occasions, and which forms an agreeable item in the programme beyond doubt.

The ceremony of the trial of the Pyx has thus been explained as explicitly as the limits of one paper in the INTELLECTUAL OBSERVER would allow, but the questions remain to be asked, Is it desirable to perpetuate the venerable performance? or has it not become an obsolete form, which might as well die out? We are disposed to think that the latter question should be answered affirmatively, and this, notwithstanding the publication of an elaborate defence of the practice in the form of a Parliamentary paper, written mainly by the Chief Clerk of the Exchequer.* Many cogent reasons might be assigned for the conclusion we have arrived at on the question of the retention or abolition of the trial of the Pyx, and for our adhesion to the opinion that it has become an utterly useless, as it is a troublesome and costly proceeding. One or two of those reasons may be introduced before leaving the subject. The first is that as the business of the Mint is at present conducted, it is quite impossible—physically and morally impossible—for any gold or silver coin "out of remedy" to leave the Mint, or to be deposited in its Pyx boxes. The operations of every department of that establishment are so governed by checks, as that no such thing can happen. The next is that if defective coins—defective as regards standard of weight or of fineness—did escape, a trial of the Pyx to which they belonged, five or six years after they had gone into circulation, would be of no earthly use, except to excite the risible faculties of the public generally. The truth is that the daily trials of the Pyx at the Mint are, in our time, of infinitely more service than the irregularly performed ceremonies at Westminster or elsewhere, and which depend not upon necessity or rule, but on the area of the Pyx boxes. The only really good argument in favour of its continuance is, that it is the prelude to a dinner at a City hall. In all other respects it is little other than a solemn farce. It is probable that the question of the continuance of the trial of the Pyx will be fully discussed during the next session of Parliament, and we have the satisfaction of thinking that a contribution is here made towards a more perfect knowledge of the subject, and which may lead to a satisfactory solution of the problem. The fact that the ancient office of the Exchequer is itself on the eve of being abolished, as a distinct department, and that the duties relating to the Pyx trials will at all events have to be transferred, seems to suggest *the period* for discontinuing those duties entirely, as apart from the Mint.

* Mr. H. W. Chisholm.

ON THE FORM, GROWTH, AND CONSTRUCTION OF SHELLS.

BY THE LATE DR. S. P. WOODWARD, F.G.S.

Edited from his MSS. by Henry Woodward, F.G.S., F.Z.S., of the British Museum.

(*Continued from page* 253, *Vol.* x. *November*, 1866.)

The Siphons.—As nearly all bivalves live buried in the sand or mud, they are furnished with more or less elongated tubes, one of which is called the inhalent and the other the exhalent siphon (see Woodcuts, Figs. 10, 12, 14, and 15).

FIG. 14. *Tellina solidula* (British).

FIG. 15. *Donax anatinus* (British).

Both having the foot protruded; the arrows indicate the inhalent and exhalent siphons.

In those bivalve forms, like *Mya*, *Lutraria*, and *Anatina*, in which the valves do not perfectly shut in the animal, the siphons lie side by side, and are enclosed in the epidermis, which is prolonged, and forms a strong horny envelope around the shell and respiratory tubes. In certain boring and burrowing bivalves, as *Gastrochæna*, *Clavagella*, and *Teredo*, the shell does not increase with age, but the siphons secrete a shelly tube in which the soft parts of the animal are incased, and the minute valves of the young mollusk are seen embedded in the wall (see Coloured Plate, Fig. 13, Vol. x., p. 241, the "watering-pot shell," *Aspergillum vaginiferum*, the minute valves are seen near the lower extremity of the tube).

The *External Ornamentation* is another very apparent cause of the immense variation in the form of shells. This is due almost entirely to *periodic growth*. All mollusca, except the Argonaut, possess a minute rudimental shell before they are

hatched, which forms the apex or the umbo of the adult shell. But the shell, in its subsequent growth, frequently differs entirely from the embryo, both in form and colour. The shell of the infant *Cymba olla* is large and very irregular; in *Magilus*, and in *Patella*, it is spiral, but afterwards becomes tubular in the former, and tent-shaped in the latter. In the *Nudibranchiata* the shell of the embryonal mollusk is shed at an early age, and never replaced. Many of the minute shells found, as well fossil as recent, are probably only the fry of larger species, and require great caution in their determination.

The size of the adult shell is often characteristic of the species, but this is by no means uniform. The author has frequently seen specimens of *Cypræa turdus*, equally adult, measuring three-quarters, to one and a half inches, but the dwarf varieties are more common than the giants.

Law of Alternation and Periodicity.—In summer and winter land-snails cease to grow. The snails of the first year, hatched in the spring, usually attain half their growth in the autumn of the same year, and their maturity in the following spring. There is always a stronger line of growth or conspicuous mark on banded and garden snails, and in some a rib inside strengthens the rim of the half-grown shell.

In the writer's cabinet are two examples of *Helix aspersa*, the common garden snail, which are grown together. They had passed the winter months hybernating in the same retreat, the one being probably nine months old, the other fifteen months. The younger snail died, having, no doubt, been killed by the frost; the survivor crept forth in the spring, bearing his deceased but irremovable companion, firmly cemented upon his back. As the living snail continued to grow, he came in due course around his own axis to the spot where the dead snail still remained fixed, and being unable to disconnect it, he formed his new shell over his attached companion, and thus in death they remain united.

Sea-snails certainly take many seasons to attain maturity, even supposing them to grow twice a year. Dredging is usually only carried on in the spring and summer months; yet a large proportion of the mollusca taken are immature. *Eulima* grows a whorl at a time, then thickens its lip and rests; ultimately a straight line is found down one side of the shell, caused by the coincidence of these "rests." In *Ranella* the line of "rests" is also coincident; but as it only grows half a turn between each, there are two rows down the spire. In *Triton* (the shell usually represented being blown as a horn by sea-deities attendant upon Neptune and Amphitrite) the "periodic mouths" form alternating nodes up the spire to the slender apex. The *Muricidæ* are extremely varied in form by

having three rows of spinous fringes produced at nearly coincident intervals on each whorl of the shell, and becoming longer with age. "Venus's comb," *Murex tenuispina*, is an instance of this, the canal of the shell being produced to twice its length, and fringed with three rows of long and slender spines, slightly curved, like the teeth of a harrow. In the Coloured Plate we give a less common example, the *Murex adustus* (Coloured Plate, Vol. x., p. 241, Fig. 7), the spines of which are extremely picturesque, reminding one of the branching fir-tree.

In the "Wentle-trap," *Scalaria pretiosa* (see Plate, p. 21, Fig. 2), the periodic mouths encircle the shell-whirls, which are sometimes separate, and contribute not a little to the beauty of this once costly conchological treasure.

Just as with the growth, we see periodic markings on the external surface of the shell, so also in the section of almost any spiral shell we see a repetition of folds around the *columella*, or internal pillar of the shell, and sometimes upon the sides of the whorls (see Plate, Vol. x., p. 245, Figs. 6 and 8).

But the most marked character in *adult* univalves is produced by the formation of a final aperture and ultimate lip to their shells. This is well seen in the "spider," or "scorpion-shell," *Pteroceras*, from China, in which the apex of the shell is concealed in a long, claw-like spine, while six others extend from the outer lip, and the canal is curved to correspond with the apical spine.

In the great fossil *Rostellaria ampla*, from the middle eocene formation of Barton, Hants, the adult animal puts forth a widely expanded lip, as broad as one's hand. In *Vermetus* (Fig. 9, Coloured Plate, Vol. x., p. 241) and *Siliquaria* (Fig. 10) the whorls become disunited in age. In *Aspergillum* (Fig. 13), each periodic growth is marked by an additional frill to its siphonal tube; and when adult, it forms the curious perforate disk from which it obtains its name.

The "Cowry" (*Cypræa*), so common an ornament upon the mantel-piece, when young, is a thin spiral shell; but when it becomes adult, it thickens its aperture enormously by repeated depositions of shell-matter, until we fail to discern the apex at all. In the Plate, Vol. x., p. 245, Fig. 7, is represented a transverse section of *Cypræa turdus*, which well illustrates this peculiarity. See also figure of *Cypræa guttata* (Plate, p. 21, Fig. 4; drawn from a specimen in the British Museum valued at £40).

But perhaps the most marked change which takes place in adult shells is to be seen in certain land-snails belonging to the *Helicidæ*. In *Gibbus Lyonetti*, from Mauritius, the shell, after forming five ordinary convolutions, suddenly makes a complete double in its growth, and remains hump-backed for

Fig. 1. Conus gloria maris.

Fig. 2. Scalaria pretiosa.

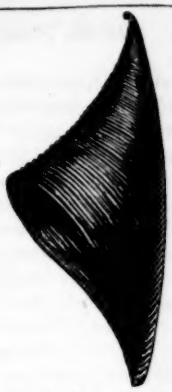

Fig. 3. Carinaria vitrea. China.

Fig. 4. Cypræa guttata.

Fig. 5. Conus nobilis.

Fig. 6. Conus cedo-nulli.

Fig. 7. Mitra Stainforthii.

Fig. 8. Mitra zonata.

Fig. 9. Voluta reticulata. Swan River.

Fig. 10. Voluta piperita.

Fig. 11. Voluta Junonia. Gulf of Mexico.

FORMS OF MARINE SHELLS.

the rest of its days. We have figured in our Coloured Plate, Vol. x., p. 241, the upper and under view of a still more eccentric land-snail, the *Helix* (*Anastoma*) *globulus* (Figs. 4 and 5), from Brazil. This snail, after growing like an ordinary *Helix hortensis*, or *arbustorum*, suddenly pulls up, and, twisting his mouth up tight, produces the aperture on a plane with the spire!

Many of these land snails not furnished with *opercula* fortify the entrance to their shell by secreting a number of shelly plates, or teeth, around the aperture (see Coloured Plate, Vol. x., p. 241, Fig. 4), so as to lead one to marvel how the occupant of the shell managed to get in or out of his own house, and still more how the eggs were excluded. In operculated *Gasteropoda* (snails with a door to their houses), the growth of the shell necessitates a corresponding enlargement of the lid, or operculum; this constantly receives fresh shelly layers from the mantle of the animal, and in those snails with a closely-fitting operculum the growth is always in proportion to that of the shell. Snails having spiral opercula (see Coloured Plate, p. 241, Fig. 3, and Plate, p. 245, Vol. x., Figs. 1 and 3) rotate their operculum slowly as they grow, so that the addition always takes place along that portion of the margin which is next the *columella*, or axis of the shell. The interior and exterior surface of shelly *opercula* are very diverse, as seen in Figs. 1, 2, and 3 of the Plate, Vol. x., p. 245.

It is absolutely essential that the mantle should cover any part of the shell to which additions are required; any injury therefore beyond the reach of the mantle externally, must be repaired from the interior. This will explain why the broken apices of univalves, and the eroded umboes of the river-mussel, are never repaired externally, but always by deposits within the spire or the valves of the shell.

In the Coloured Plate which accompanied the earlier pages of this article, in November last, p. 241, we gave a number of illustrations to show the extreme variation in the form and growth of shells. In the plate which accompanies the present part, at p. 21, we offer an additional series, in which we not only notice variations in form, due to growth, etc., but also a great variation in ornamentation resulting from colour. There are few shells more persistent in form than are the "Cowries" (*Cypræa*) and Cones (Figs. 1, 4, 5, and 6); but the former numbers upwards of 150, and the latter more than 200 species, chiefly distinguished by the diversity of their colouration. The Mitras (Figs. 7 and 8) are even more numerous than the Cones (having some 400 species), many of which are striking illustrations of brilliancy of colour.

The Volutes (Figs. 9—11), though a less numerous generic division, contain nevertheless, many shells remarkable for

variety and richness of painting. These four genera include probably the rarest and most costly shells that are known, and few persons, we think, can fail to appreciate their beauty.

Yet the shell in the Cowry and Volute is concealed within the folds of the mantle; in the Cone, it is covered by a thick and rough epidermis, which has to be removed before its hidden beauties are discovered. "God's works," writes Prof. Forbes,* "are never left unfinished. None is too minute for the display of infinite perfection. The microscope has exhibited to our wondering eyes beauties of structure that have been concealed from mortal sight for long ages. It would almost seem as if only glimpses of those excellencies of creation are permitted to man to behold, whilst the full contemplation of such wondrous charms is reserved for immortal and invisible admirers."

But living mollusks not only secrete shell-matter; they have likewise the power to absorb the internal convolutions and *columella* of their shells, either completely, or until it is reduced to the thinnest film. The cone removes all but a paper-like portion of its inner whorls (see Plate, Vol. x., p. 245, Figs. 4, 5, longitudinal and transverse section of *Conus tesselatus*), and the *Cypræa* (Fig. 7) often goes still further in removing all trace of its axis.

The *Olivæ* and *Neritidæ* likewise remove the internal spiral column of their shells; and the *Auriculidæ*, among land-snails, do the same.

This power of dissolving shell is also used by the *Muricidæ* in removing those external spines which would interfere with the continued growth of the shell.

Hermit-crabs in like manner increase the accommodation of their houses by breaking away the internal axis and convolutions of the shell they inhabit. In the writer's cabinet is a *Bulmius* shell from the Antilles, inhabited by a land hermit-crab (the *Cenobita Diogenes*), which has been completely cleared from its columella, and made into one commodious chamber within.

Nearly all the peculiarities in the form of shells relate to some special function or habit of life of the animals which inhabit them.

Perhaps one of the most important functions which requires to be provided for is that of respiration. We have already seen that in many of the burrowing bivalves, the siphons cause the shell permanently to gape at the end to accommodate them. Again, in the univalves, the aperture of the shell is usually found to be characteristic of the division to which the animal belongs; the mouth being entire in most of the

* *British Mollusca*, Introduction, p. xv.

vegetable feeders (or *Holostomata*) (see Coloured Plate, Vol. x., p. 241, Figs. 2, 3, 4), and notched, or produced into a canal in the carnivorous families (or *Siphonostomata)* (see same Plate, Fig. 7—and Plate, p. 21, Figs. 7—11). But this canal, or siphon, is *respiratory* in its office, and must not, therefore, be taken as a *certain* indication of the nature of the animal's food. Thus, for example, *Scalaria pretiosa* (Plate, p. 21, Fig. 2) has a holostomatous aperture, but is known to be carnivorous in its diet. If we refer back to the figures of the dog-whelk (*Nassa reticulata*, Vol. x., p. 247), and the common whelk (*Buccinum undatum*, p. 248), we shall see the long incurrent siphon protruding from the canal of the shell and turned upwards. Into this tube the water passes, and enters a vaulted chamber (formed by an inflection of the mantle of the animal), which contains the pectinated, or plume-like gills. After traversing the length of the gills, it returns and escapes through a posterior siphon, generally less developed than the anterior one, but very long in *Ovulum volva*, and formed into a tube in *Typhis*.

The object of the long siphon in the whelk is to enable it to respire freely while burrowing in the sand in search of its prey—the poor defenceless *Mya*, and other bivalves. The *Ampullaria* has also an extremely long siphon, which enables it to breathe, when it retires deep beneath the river mud during the dry season.

In the ear-shell (*Haliotis*), found living on the rocks at low-water in the Channel Islands and elsewhere, and so common a mantel-piece ornament, on account of its pearly interior; the excurrent siphon is accommodated by a hole near the lip of the shell, repeatedly renewed with the growth of the animal. In the key-hole limpet (*Fissurella*), the anal siphon passes through the perforation on the summit of the shell.

In *Siliquaria* (see Coloured Plate, Fig. 10, Vol. x., p. 241), the notch for this siphon remains unclosed, so that as the shell grows, it prolongs the fissure through the whole length of its tube.

In those mollusks whose shell is reduced to a mere rudimentary organ, we still find that its design and object is, primarily, to protect the heart and breathing organs. Thus, in *Testacella* (Fig. 4, Vol. x., p. 245) it covers the *hemal*, or heart-region, and again in the keel-shell, *Carinaria* (see Plate, p. 21, Fig. 3), in which the shell is less than one-seventh part the size of the body of the animal, its only use is to cover the branchiæ.

Lamp-shells (*Brachiopoda*).—These curious bivalves are symmetrical in form, and nearly always have the dorsal valve smaller than the ventral, the latter being produced into a

beak, through which is an aperture for the passage of the pedicel, by which the shell is attached to foreign bodies in the sea.

The ancient Etruscan and Roman lamps have so much the general form of these shells as to have given rise to the name "lamp-shells," the beak with its pedicel corresponding to the spout of the lamp through the hole in which the wick passes. On the Coloured Plate (see Vol. x., p. 241, Fig. 11) we figure *Waldheimia* (*Terebratula*) *Australis*, an elegant form, named after the accomplished Russian naturalist, Fischer de Waldheim. The visitor to the shell-gallery of the British Museum may see in the Brachiopod case, a stone dredged up by Professor J. Beete Jukes, in Port Jackson Harbour, Sydney, New South Wales, to which more than thirty specimens of *Waldheimia* are attached.

The shell-valves of the *Terebratula* are articulated together by two curved teeth arising from the border of the ventral, or beaked valve, which fit into two sockets in the other.

So complete is this hinge that it cannot be separated without injury to the shell; nor can the valves of *Waldheimia* be opened more than one-eighth of an inch without applying force.

If we rupture the hinge of any recent specimen we shall see that the muscles and digestive organs of *Terebratula* occupy an extremely small space near the beak of the shell, and are partitioned off by a membrane from the general cavity, which is occupied by the fringed arms that give rise to the name (*Brachiopoda*), it having been supposed that these organs corresponded with the foot of the *Gasteropod*. But it seems more correct to consider the pedicel as the true representative of the molluscan foot. These ciliated arms are variously modified in the different genera. They form two separate spiral coils in *Rhynchonella* and *Lingula*, but are united together by a membrane, and are only spiral at their tips, in *Terebratula* and *Discina*.

In *Waldheimia*, the smaller, or dorsal valve, which is fitted with the hinge-sockets, is also provided with a shelly loop in its interior, for the support of the fringed arms. These fringed arms correspond with the labial tentacles of the ordinary bivalves and the ciliary organs around the mouths of Polypes.

Few mollusks present points of greater interest than do the *Brachiopoda*. They all inhabit the sea; the fully developed shell being always found attached to rocks, or stones, branches of coral, or to other shells. The young (although their development has not as yet been recorded) are doubtless unattached, and able to swim freely, like the fry of

other bivalve mollusca, until they meet with suitable places for attachment.

They are found from low water to one hundred and twenty fathoms, and probably even deeper, and are distributed almost in every sea at the present day, whilst their range in geological time is only equalled by such forms as the microscopic *Foraminifera* and *Entomostraca;* species of fossil *Lingulæ* being met with in our oldest Cambrian and Silurian formations. At present only seventy living species have been met with, but as they are for the most part inhabitants of deep water, no doubt many more will be discovered, for good marine dredges are a comparatively modern invention, and deep-sea dredging is no easy task, as the writer can testify from personal experience on the coast of Spain.

More than one thousand extinct species of *Brachiopoda* have been described, representing, of course, a succession of geological periods, so that it is not improbable that they are nearly, if not quite, as numerous at the present day as formerly.

Some of the fossil species attained a very large size, and the palæozoic genera present remarkable variations in form from each other, and also from any now living. Dr. Gustaf Lindström has lately separated one group entirely, and placed them in a separate order, to be called, Operculated Radiata of the order *Rugosa*.

Floating Shells.—The *Pteropoda*,* or "wing-shells," furnish good illustrations of this form of molluscan life (see Coloured Plate, Vol. x., p. 241, Fig. 1, *Cleodora pyramidata*). "This little group consists of animals whose entire life is passed in the open sea, far away from any shelter, save what is afforded by the floating Gulf Weed, and whose organization is specially adapted to that sphere of existence. In appearance and habits they strikingly resemble the fry of the ordinary sea-snails, swimming, like them, by the vigorous flapping of a pair of fins. To the naturalist ashore they are almost unknown, but the voyager on the great ocean meets with them where there is little else to arrest his attention, and marvels at their delicate forms and almost incredible numbers. They swarm in the tropics, and no less in Arctic seas, where by their myriads the water is discoloured for leagues (*Scoresby*). They are seen swimming on the surface in the heat of the day, as well as in the cool of the evening. Some of the larger kinds have prehensile tentacles, and their mouths armed with lingual teeth; so that, fragile as they are, they probably feed upon still smaller and feebler creatures (*e.g.*, *Entomostraca*). In high latitudes they are the principal food of the whale, and of many sea-birds. Their shells are rarely drifted on shore, but

* So called from πτερον, a wing, and ποδος, ποδος, a foot.

abound in the fine sediment brought up by the dredge from great depths. A few species occur in the Tertiary strata of England and the continent; in the older rocks they are unknown, unless some comparatively gigantic forms (*Conularia* and *Theca*) have been rightly referred to this order." (Woodward's *Manual of Mollusca*, p. 202.)

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beak, through which is an aperture for the passage of the pedicel, by which the shell is attached to foreign bodies in the sea.

The ancient Etruscan and Roman lamps have so much the general form of these shells as to have given rise to the name "lamp-shells," the beak with its pedicel corresponding to the spout of the lamp through the hole in which the wick passes. On the Coloured Plate (see Vol. x., p. 241, Fig. 11) we figure *Waldheimia* (*Terebratula*) *Australis*, an elegant form, named after the accomplished Russian naturalist, Fischer de Waldheim. The visitor to the shell-gallery of the British Museum may see in the Brachiopod case, a stone dredged up by Professor J. Beete Jukes, in Port Jackson Harbour, Sydney, New South Wales, to which more than thirty specimens of *Waldheimia* are attached.

The shell-valves of the *Terebratula* are articulated together by two curved teeth arising from the border of the ventral, or beaked valve, which fit into two sockets in the other.

So complete is this hinge that it cannot be separated without injury to the shell; nor can the valves of *Waldheimia* be opened more than one-eighth of an inch without applying force.

If we rupture the hinge of any recent specimen we shall see that the muscles and digestive organs of *Terebratula* occupy an extremely small space near the beak of the shell, and are partitioned off by a membrane from the general cavity, which is occupied by the fringed arms that give rise to the name (*Brachiopoda*), it having been supposed that these organs corresponded with the foot of the *Gasteropod*. But it seems more correct to consider the pedicel as the true representative of the molluscan foot. These ciliated arms are variously modified in the different genera. They form two separate spiral coils in *Rhynchonella* and *Lingula*, but are united together by a membrane, and are only spiral at their tips, in *Terebratula* and *Discina*.

In *Waldheimia*, the smaller, or dorsal valve, which is fitted with the hinge-sockets, is also provided with a shelly loop in its interior, for the support of the fringed arms. These fringed arms correspond with the labial tentacles of the ordinary bivalves and the ciliary organs around the mouths of Polypes.

Few mollusks present points of greater interest than do the *Brachiopoda*. They all inhabit the sea; the fully developed shell being always found attached to rocks, or stones, branches of coral, or to other shells. The young (although their development has not as yet been recorded) are doubtless unattached, and able to swim freely, like the fry of

other bivalve mollusca, until they meet with suitable places for attachment.

They are found from low water to one hundred and twenty fathoms, and probably even deeper, and are distributed almost in every sea at the present day, whilst their range in geological time is only equalled by such forms as the microscopic *Foraminifera* and *Entomostraca*; species of fossil *Lingula* being met with in our oldest Cambrian and Silurian formations. At present only seventy living species have been met with, but as they are for the most part inhabitants of deep water, no doubt many more will be discovered, for good marine dredges are a comparatively modern invention, and deep-sea dredging is no easy task, as the writer can testify from personal experience on the coast of Spain.

More than one thousand extinct species of *Brachiopoda* have been described, representing, of course, a succession of geological periods, so that it is not improbable that they are nearly, if not quite, as numerous at the present day as formerly.

Some of the fossil species attained a very large size, and the palæozoic genera present remarkable variations in form from each other, and also from any now living. Dr. Gustaf Lindström has lately separated one group entirely, and placed them in a separate order, to be called, Operculated Radiata of the order *Rugosa*.

Floating Shells.—The *Pteropoda*,* or "wing-shells," furnish good illustrations of this form of molluscan life (see Coloured Plate, Vol. x., p. 241, Fig. 1, *Cleodora pyramidata*). "This little group consists of animals whose entire life is passed in the open sea, far away from any shelter, save what is afforded by the floating Gulf Weed, and whose organization is specially adapted to that sphere of existence. In appearance and habits they strikingly resemble the fry of the ordinary sea-snails, swimming, like them, by the vigorous flapping of a pair of fins. To the naturalist ashore they are almost unknown, but the voyager on the great ocean meets with them where there is little else to arrest his attention, and marvels at their delicate forms and almost incredible numbers. They swarm in the tropics, and no less in Arctic seas, where by their myriads the water is discoloured for leagues (*Scoresby*). They are seen swimming on the surface in the heat of the day, as well as in the cool of the evening. Some of the larger kinds have prehensile tentacles, and their mouths armed with lingual teeth; so that, fragile as they are, they probably feed upon still smaller and feebler creatures (*e.g.*, *Entomostraca*). In high latitudes they are the principal food of the whale, and of many sea-birds. Their shells are rarely drifted on shore, but

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we should need a much more extensive and intimate knowledge of those which preceded the present races, in order to show that their relationship was that of descent. All we can now say is, that the present races closely resemble their immediate predecessors, and are more and more unlike the shells of older geological times. One fact is very apparent, that a great many have become extinct because they could not change and adapt themselves to new external conditions. Many have also become extinct in the regions where they once abounded, but still linger, in diminished numbers, in out-of-the-way localities, where the hostile influences were less severe.

MRS. CAMERON'S PHOTOGRAPHS.

In a former number we made some remarks on *Photography as a Fine Art*, and spoke of the success which had attended Mrs. Cameron's efforts to produce works more in accordance with the productions of great painters, than had hitherto been done by mechanical and chemical means. Since then we have examined a great many of this lady's photographs, and the high opinion we formed of them, not only on account of their individual merit, but also as tending to found a distinct school of photography, characterized by very remarkable qualities,—artistic and manipulative, have been confirmed. Like all innovators, Mrs. Cameron has had, and we might say has still, much prejudice to overcome; but if our readers will pay a visit to her portfolios, which may be seen at the well-known establishment of Messrs. Colnaghi, we are quite sure that those who possess the greatest knowledge of pictorial art, and the finest perceptions of beauty, will be the warmest in their admiration, and the loudest in their praise. Finely executed works by photographers of established reputation, no doubt exhibit qualities of a very meritorious kind, but it is very rarely that they produce anything like the feelings and sensations which arise in our minds, on contemplating pictures of, or fine engravings after, such artists as Correggio, Van Dyck, or Sir Joshua Reynolds. We accept the human face done into photography, as a species of translation into a language, imperfectly capable of expressing the required ideas, and rendering them, so far as it can do so, rather by an artificial and non-natural idiom, than by a simple and satisfactory phrase. Many things that add a charm to the countenance, such as the very delicate gradations of light and shade, which

give the sense of roundness, softness, and smoothness to the cheek, the transparent shadowiness lurking amongst tresses of hair—the varying tones of flesh colour—the suggestions of life and movement, which delight us in real figures possessing the requisite beauty, and in suitable positions, and which meet us in the delineations of the great masters, are wanting in the ordinary photograph, and have been marvellously introduced by Mrs. Cameron, in her processes of photographic art.

The most remarkable instance of this artist's success, is to be found in the child's head, "Number 6 of the series of twelve life-sized heads" and called "Alice." It has all the properties of a fine sepia drawing by a great master. It is rich in gradations of tint. The hair flows freely in fine masses, as if the wind had caught it: stray locks have swept across the forehead, and their delicate shadows give an exquisite softness to the brow. Beautiful hair, left free, is one of the most poetic of nature's productions, and very subtle and sympathetic are the combinations of light and shade which it exhibits, and which defy the efforts of ordinary artists to reproduce. Few of the old painters did justice to hair. They usually painted it in forms too stiff, and the ordinary photography reduces it to wires, or threads. Alice's hair is a masterpiece of art, and Mrs. Cameron has made her photographic apparatus succeed in producing those delicate transparent shadows which sorely test the manipulative skill of the oil painter.

This head of "Alice" exemplifies other fine qualities usually absent from photography. A good photographer of the common sort seldom approaches a grand mode of treatment. If his lights and shadows are strong and in conspicuous masses, they are generally damaged in artistic effect by the violence of their contrasts. The depths are too black, and the lights too white, and there is a want of half-tones. Another common photographic defect is giving too much prominence to detail, as the early artists did, and as the modern Pre-Raphaelites continue to do. Mrs. Cameron has advanced photography beyond this stage. In "Alice," and in other productions, she has introduced breadth and generalization; her contrasts are strong, but not violent, and she has been singularly successful with half-tones. The qualities we have mentioned belong to what we may call the technical, or manipulative branch of art; and they are essentials to success; but something more is wanted: a true work of art is also a work of mind, and Mrs. Cameron has rescued photography from mere copying. In her life-sized heads, as well as in her composition pieces, she has evinced rare faculties of dealing with the emotions of her sitters. She does not take them anyhow, but draws them out, and induces in them such a condition of mind and feeling as

gives rise to a vivid and pictorial expression of feature. Her process is not a quick one, and she must have unusual tact and skill in keeping her subjects happy, and in the mood she wants. One cause of failure in the expression of ordinary photographic portraits no doubt arises from the uncomfortable situation in which the subjects find themselves. Who can look interesting or natural in a glass garret, bothered with directions to stare at a brass knob: told when to wink, and ordered to sit still. "Wet your lips, and wink your eyes," were the directions to a party of ladies at one establishment; and others may, for aught we know, have recourse to Dickens' "prunes, prisms, and papa," to get the mouth into the required state. Those portrait painters who have been most successful in giving life-like expression to their works, have possessed the art of influencing the mental condition, and drawing out their subjects; and those photographers who wish to rise above the mechanism of their profession, must cultivate it, and must arrange their studios so as to make comfort, and natural expression, possible in them.

No. 12 of Mrs. Cameron's "life-sized heads" is so far a misnomer as it is *enlargement* of life, admirably done. It represents a noble-looking boy, a sort of young Jupiter, but with a touch of Mercury's mischief and fun. We have noticed that the size of this head puzzles many ordinary people, who would have admired it on a smaller scale, and it wants some little artistic education to appreciate any figures verging on the colossal. Placed at a suitable distance it is singularly effective, and artists view it with delight. In this piece Mrs. Cameron has thrown aside all tame conventionalism. The vigorous, free, natural treatment of the subject is worthy of a great sculptor, and if we regard "Alice" as the most pictorial of her portraits, this may be called the most statuesque.

We have not seen the original children of these portraits, and therefore can offer no opinion of how far Mrs. Cameron's process realizes a likeness, but we should imagine, from the vivacity and depth of expression, her success in this particular must be great. What is, however, most remarkable is, the extent to which she has made her portraits works of art. No one unconnected with the family would care to have photographs of Miss Brown or Master Jones, as such things are ordinarily done, even if the children were above the average in good looks, but a child painted by Correggio or Guercino is another thing. We do not ask the name of the model, but we prize the picture for qualities higher than those of mere resemblance to a particular person. Mrs. Cameron's "Alice" and the Jupiter-like boy belong to this rare and high class of

portrait which every one of artistic perception is so glad to possess.

Those of our readers who live in, or visit London will, no doubt, go to Colnaghi's, and look through the large collection of Mrs. Cameron's works, which are on sale at very moderate prices, and we recommend them to pay particular attention to her dramatic and composition pieces. Some effective theatrical pieces, with portraits of popular actors, have often been taken by the ordinary photographers, but Mrs. Cameron has set to work in a different way, and has made her pictures by getting her friends or acquaintances to form *tableaux vivants*, and then photographing them with her peculiar skill. We can only allude to this important branch of her new art, one of the finest specimens of which is a "Prospero and Miranda," marked "from life." This piece will be a great favourite as it becomes known, because it tells its tale so forcibly, and is remarkably pleasing in its character. A fine old Prospero, with vigorous features, long white beard, and intellectually-developed forehead, recounts to an intensely-listening, earnest-looking Miranda, the story of her birth, and his expulsion from his dukedom. At the moment of the picture, Prospero is standing up, and Miranda, leaning forward, clasps one of his hands as if to give assurance that her soul was in his tale. The light glances down Prospero's forehead with its strong lines of thought, on Miranda's face, and on a portion of her simple dress. The background is very dark, and while Miranda's figure is distinct, Prospero's is only indicated—not shown. We have very few artists who could paint half so fine a picture of the scene as Mrs. Cameron has given us in this piece. We could fancy she had fished up a leaf of Prospero's "drowned" book, and rescued his staff from its burial-place "certain fathoms in the earth," when we notice the skill with which in this case, and in "Queen Esther," and several others we might name, she has composed her living pictures, and made her apparatus give them a permanent form.

It will soon become the fashion to admire these productions. Their novel merit now charms the few who know how to think for themselves on matters of art, and the many will bring their later, but useful homage, when fashionable authorities have told them it is the correct thing to do. Mrs. Cameron has only to persevere, and she will found a school of "Cameronians," though not after the fashion of the grim sect so named. Her productions are eminently genial, and from this quality and from their beauty they will find their appropriate resting-places in cultivated homes.

THE COAL MINES OF THE UNITED STATES OF NORTH AMERICA.*

BY P. M. LUBBREN.

In the United States coal is abundant, and can never be exhausted. Between the western extremity of the Appalachian coal-fields and Cincinnati, the different formations, from the Devonian to the Lower Silurian, come up to the surface in succession. At Portsmouth, next the lower coal measures, comes the inferior, or conglomerate grit, or millstone; next it, the Waverly sandstone, the equivalent of the Devonian. Then succeed the Upper Silurian slates and limestones, and lastly, at Cincinnati, the lower Silurian groups appear in the hills and beds of the Ohio.

There is one vast coal-field extending from New York to Alabama, which covers nearly one hundred thousand square miles. Another coal-field in Indiana embraces about fifty-five thousand square miles. Another in Michigan covers about twelve thousand square miles. The grand total amounts to two hundred and twenty-five thousand square miles, and the whole amount of coal, estimating the average thickness of the beds to be fifty feet, would be three millions and a half of cubic miles, a quantity absolutely inconceivable.

Before the late civil war, the average price of coal in Pennsylvania was five dollars per ton, and in New York not far from six dollars per ton.† The relative cost of transportation to New York and to London from the mines was then about the same.

The principal portion of the coal used in the United States for domestic purposes is brought from Pennsylvania. This coal is anthracite, or hard, and the only large deposits of this species of coal of a good quality in the United States, so far as is known, are found in that region. Anthracite coal exists in Rhode Island and Massachusetts, but it is much less combustible than in Pennsylvania.

The remainder of the vast coal-fields which we have enumerated comprise coal which is more or less *bituminous*, and is more commonly used in this country for generating steam than for domestic purposes. It is similar, however, to the English

* *State Survey of Pennsylvania.* By Professor H. D. Rogers.
Statistical Report on the Iron and Coal of Pennsylvania. Prepared by Dr. Charles M. Wetherell, and published in a work entitled *Science and Mechanism*, 1853-4.
State Survey of New York. By Mr. Hall. Albany, 1843.
State Survey of Virginia. By Professor W. B. Rodgers.

† Since the civil war the price of coal is more than double.

coal, and could be as readily burned in grates. The coal formations of this country, although the mineral differs in character, are of the same geological era. The difference in the amount of bitumen is caused by the greater disturbance to which some portions of the coal-fields have been subjected.

The hard coal is found on the slopes of the Alleghanies, where, by the upheaval of heated mineral masses, the bitumen has been expelled, and the coal converted into anthracite. The bitumen in coal increases as the beds pass westward towards the Mississippi, where, as well as on the Pacific shores, the quantity of bitumen is equal to that in English sea-coal.

There are three great anthracite coal-fields in Pennsylvania, namely, the Southern, Middle, and Northern.

I. The southern coal-field is divided into four mining districts, the Lehigh, the Schuylkill, the Swatara, and the Susquehannah.

II. The middle coal-field is north of the southern, having the Beaver meadow mines in the eastern extremity, and the Shamokin and Mahony mines on the Susquehannah.

The Shamokin mines, are worked horizontally by digging into the mountain. This coal is called the "Peacock," on account of the brilliant golden purple and green tints it presents to the eye, but it is not as durable as the coal from the Pottsville and other mines, burning either to a white or red ash. It ignites easily, and burns very brightly.

III. The northern coal-field lies twenty-five to thirty miles east of the Middle Basin, including the Wyoming and Lackawanna valleys, and finds its market in New York.

The following remarks will be confined to a brief notice of the southern coal-field.

Canals and railroads have been constructed here with a boldness of design and magnificence of enterprise that will compare with any works of the kind in this or the old world.

This field is sixty-five miles in length, and averaging about four miles in width, and enclosed or bounded by a continuous mountain, which separates it by about ten miles from the second coal-field, forming a longitudinal basin. This boundary is called Broad Mountain on the north, and Sharp Mountain on the south, and is penetrated by the rivers Schuylkill and Swatara, which afford the inlets for the necessary canals and railroads.

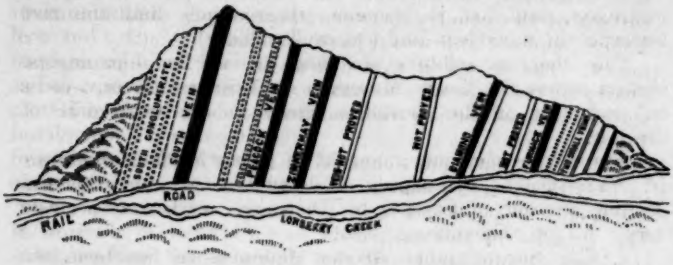
1. The nearest anthracite coal-field to tide-water is on the Lehigh river. The Lehigh river, however, unlike the Schuylkill and Swatara, does not penetrate the coal-field, and hence the coal-mines could only be reached by ascending and descending, through inclined plains and railways, Sharp

Mountain at its greatest elevation. From the basin, when thus reached, the coal is transported by stationary power a distance of nine miles to the navigation at Mauch-Chunk. There is nothing in the States that surpasses the enterprise here exhibited, to overcome the obstacles presented by the surface of the country between these mines and the river Lehigh, and nothing would have justified the outlay but coal mines. The mines in this district are worked like an open quarry on the slope of a mountain, and the coal is conveyed as stated by a self-acting railroad down a declivity from 100 to 140 feet per mile to the canal. This navigation was completed in 1820, and 3657 tons delivered that year in Philadelphia, and in 1847 the quantity increased to 643,272 tons, and the trade has been increasing at a ratio, per annum, of twenty per cent. The capacity of this navigation by the Delaware division of the Pennsylvania canal and the Morris canal has been considered fully equal to the transport of a million and a half tons of coals.

2. The Schuylkill district is the centre of the basin, and is very extensive, embracing more than one-half of the entire field, viz., the mines of Tamaqua (which adjoin the Lehigh mines), Tuscarora, Port Carbon, Pottsville, Minersville, and Tremont. In this anthracite coal-field of Schuylkill county, whose outlets are at Mount Carbon, Port Carbon, Schuylkill Haven, and Port Clinton are one hundred and eleven collieries, of which fifty-eight are red ash coal and fifty-three white ash; sixty-two of these collieries are working coal out above water-level, and forty-nine below water-level. There was shipped from this region a total of 2,450,950 tons in the year 1852. The thickest vein worked is thirty feet, and the smallest two feet.

3. The Swatara district commands a rich and most valuable portion of the coal-field, and is mined through the channels of the Union Canal Company, and Susquehannah and Tidewater Canal. It averages about eighteen miles long by six broad, containing 69,120 acres of coal-land. In this mining district are seven hills from 300 to 800 feet in height, running parallel, or nearly so, separated by narrow valleys, which in some places, remote from the streams, are nearly level with the mountain ridges, but which near the gaps are worn down by the water-courses which drain the coal-basin. In these high ridges are deposited the veins of coal; they are called the Sharp Mountain, the Red Mountain, the Coal Mountain, the Little Lick, the Big Lick Mountains, the Thick Mountain, and the Broad Mountain. The Swatara river or its branches are broken through all these ridges, except the Broad Mountain, at which it penetrates. The coal of the Sharp Mountain is of the red ash variety. It is a free burning coal, ignites

easily, leaves but little residuum, burns with a bright yellow blaze, without smell or smoke, and is an excellent article for blacksmithing, as well as for parlour purposes. The expenditure in this region up to 1847 has not been great. In that year 61,000 tons were exported.



SHARP MOUNTAIN OF THE SWATARA MINING DISTRICT, PENNSYLVANIA.

Scale 400 Feet to the Inch.

South Conglomerate, about 120 feet thick.	Diamond Vein, 3 feet thick.
South Vein, 5 feet thick.	Furnace Vein, 6 „
Peacock Vein, 8 „	From South Conglomerate to Furnace Vein, 1680 feet.
Zimmerman Vein, 4 „	

The Sharp Mountain lies next to the southern boundary of the coal-field. Its length in the Swatara Mining District is more than twenty miles, rising in some places 800 feet from its southern base. On the west side of Lorberry Creek Gap, the pinnacle called the Panther's Head is 725 feet higher than the railroad. The Great Conglomerate is at the southern base of the mountain. Here are no "horizontal heaves," or derangement of the coal-measures, as is the case in the Schuylkill district. The veins at Lorberry Creek run directly across the creek, from the mountain on one side to the mountain on the other. Their course on both sides of the gap, is north 68° east. Those in the southern half of the mountain having a south dip of about 74°, and those in the northern half about 67°.

The *Conglomerate*, which forms the general base of the coal-measures, is 1500 feet thick in the Sharp Mountain near Pottsville; whereas it has only a thickness of 500 feet about thirty miles to the north-west, and dwindles gradually away to thirty feet. The *Limestones*, on the other hand, of the coal measures, augment as we trace them westward. Similar observations have been made in regard to the *Silurian* and *Devonian* formations in New York; the sandstones and all the mechanically-formed rocks thinning out as they go westward,

and the limestones thickening as it were at their expense. It is therefore clear that the ancient land was to the east; the deep sea with its banks of corals and shells to the west; and from the identity of fossil plants and the relative position of the anthracite, it must be of the same age as the bituminous. We find the coal most bituminous where it remains level and unbroken, and that it becomes progressively debituminized towards the more bent and distorted rocks.

The diagram exhibits the veins of coal by a geological section across the Sharp Mountain at Lorberry Creek. It is an end vein of the Panther's Head on the west side of the gap.

For further particulars consult *A Report to the Legislature of Pennsylvania*, containing a description of the Swatara Mining District, illustrated by Diagrams, with a very large map. 61 pp., Harrisburg, 1839.

4. The Susquehannah district embraces the western terminus of the southern coal-field, branching out into two divisions towards the Susquehannah—the southern, or Stony Creek coal region, and the Lyken's Valley. The basin is thirty-two miles long by four and a half in breadth. The primitive position of the vein of coal of this region is generally unchanged, as a consequence rendering their investigation and development much more easy, and less liable to the occurrence of those "faults" and "breaks" which have proved so disastrous to capital and discouraging to labour in other regions. The thickness of the beds of coal in this region is estimated at twenty-nine feet, yielding at least 60,000 tons to the acre. Over half a million tons of coal are sent annually hence to market.

The coal-lands are generally owned by corporations or wealthy individuals, and are leased to operators, who pay a certain fixed sum for every ton mined. The coal is consigned to commission-merchants, by whom it is sold by the cargo, generally upon contracts made early in the season.

The coal is procured by driving drifts into the mountain ends, or by sinking sloping shafts and putting engines upon the veins. When the first level of a slope is sunk down, the coal is mined with comparative facility and little expense. This level will last from four to six years if the veins and the run upon it be fair, but at the end of that time a new level must be sunk, and the slope must be doubled in depth; in fact, a new mine must be created 350 feet below the surface, and when "faults" are met, bankruptcy often ensues. Indeed, few have ever successfully overcome the third level of a slope.

From statistics of coal mined in the United States during

the year 1860, ending on June 1st, it appears that the total amount of anthracite coal mined was 9,398,332 tons. Of this, 1000 tons came from Rhode Island, and all the rest from Pennsylvania. The amount of bituminous coal mined in the same year was 5,842,559 tons. Of this, Pennsylvania supplied about 2,700,000 tons. The anthracite coal was valued at 11,874,574 dollars, and the bituminous at 7,526,681 dollars, making a total of 19,401,255 dollars.

ADDENDA.

On the roofs of the coal seams are shales with distinct impressions of ferns, as the *Pecopteris lonchitica*, the *Neuropteris cordata*, and stems and trunks are found of the *Lepidodendron, Calamites, Sigillaria* and *Stigmaria*, of which latter there is an abundance in the mines at Blossberg, Pennsylvania, often several yards long with their leaves and rootlets attached.

STATISTICS OF COAL MINES IN THE UNITED STATES IN THE YEAR ENDING JUNE 1ST, 1860.

The following statistics of the coal mined in the United States during the year 1860 appeared in the report of the last census:—

	Bituminous.		Anthracite.	
States.	Bushels.	Value.	Tons.	Value.
Rhode Island	95,000	$28,500	1,000	$5,000
Pennsylvania	66,994,295	2,833,959	9,397,332	11,719,574
Maryland	11,200,000	461,338		
Ohio	28,339,910	1,539,713		
Indiana	379,035	27,000		
Illinois	14,258,120	964,187		
Iowa	72,500	6,500		
Missouri	97,000	8,200		
Tennessee	3,474,100	413,662		
Kentucky	6,732,100	476,800		
Virginia	11,229,675	725,678		
Alabama	10,000	1,200		
Georgia	48,000	4,800		
Washington Territory	134,350	32,244		
Bushels	146,063,975	$7,526,681		

Twenty-five bushels to a ton is 5,842,559 tons.

Anthracite tons	9,398,332	$11,874,574
Bituminous tons	5,842,559	7,526,681
		$19,401,255
Value of coal mined in 1850, agreeably to census returns		$7,173,750
Increase (171 per cent.)		$12,227,505

ON TELEGRAPHIC COMMUNICATION BY MEANS OF A NUMERICAL CODE.

BY LIEUT. J. HERSCHEL, R.E.

THE object of telegraphy is the transmission of a series of WORDS, *signs*, or *symbols*, representing ideas; and this object will be best attained when those words, signs, and symbols are transmitted with the least possible expenditure of labour and time, consistently with a minimum risk of error. To arrive at a just conclusion as to the means to this end, it is necessary to consider the nature of these words, signs, and symbols, and, possibly, of the ideas which they represent.

The *signs* and *symbols* which it is required to transmit are few in number as compared with the words: the letters of the alphabet, the ten numerals (not necessary since they have *names*, or may be represented by words), and a very limited number of symbols, such as punctuation signs, algebraical signs, etc. (which may for the most part, if not entirely, be known, like the numerals, by their *names*, or the words representing them); these include all that, in practice, it is desirable to transmit of this class.

The principal medium of communication of ideas is *words*. All words are susceptible of scription in letters, and existing telegraphy does transmit them by means of the letters which compose them, or at any rate by the transmission of the more important letters which form the words. By a "word," I understand any combination of letters which has an accepted signification, whatever place that combination or word may have in syntax or grammar, or whatever its signification may be. Existing telegraphy therefore may be understood to communicate ideas by the transmission of a series of combinations, simple or complex, of a limited number of symbols and letters. Assuming that telegraphy can, in practice, only transmit simple signals, out of which can be formed a variety of combinations, it is clear that the simplicity of communication must depend on that of the combinations necessary to represent the words, etc., communicated. Now the primitive signals are but two in number, by the repetition and arrangement of which letters, symbols, and numerals are represented. These latter may be called the telegraphic alphabet; and it is evident that the more extended this alphabet, the greater the variety of the arrangement of the primitive signals must be. According to the existing system this alphabet contains at least *forty* individuals. It is the object of these remarks to show that *ten* will suffice; and even should it appear that the actual

number of "telegraphic letters" transmitted for a given message, would be greater with such a curtailed alphabet, than would be the case with the existing one, it is contended that the immediate gain from this reduction would outweigh the disadvantage which a more copious alphabet labours under, of requiring a more elaborate arrangement and a greater number of repetitions of the primitive signals. But in point of fact the actual number of telegraphic letters transmitted would also be less. For words are *special* combinations, and since a vast number of possible combinations are excluded, which do not form words, the existing combinations which do form words must contain a much larger number of components than would be the case were every available combination occupied by a recognized word. We shall not be far wrong if we assign five as the average number of letters in an English word. Perhaps the true average is a fraction less than five, but if we take into account the habitual omission in telegraphy of unimportant words (which are always short), the estimate will stand good. Now the number of possible combinations of ten symbols, five or less in each, is 100,000. This is clearly greater than the actual number of recognized words in the English (or any) language which has the command of twenty-six symbols, and is not restricted even to twelve or fifteen of them in the formation of any word. Not only then may every useful word of the English language, and of the French too, be represented by a different combination of five symbols out of ten, but a large margin will remain available for almost any conceivably useful variety of signs or phrases. They will not require the transmission, on the whole, of a greater number of symbols or "telegraphic letters" than are now transmitted; but, on the other hand, will require a very much smaller number of "primitive signs" or impulses.

What, now, are the disadvantages of such a system of signals? The principal one is the necessity of a dictionary. A telegraphic dictionary would have to be compiled, and invariably used at both ends of the wire (but not necessarily at intermediate repetition stations). A vast amount of care, and knowledge, and foresight might be spent with advantage in the compilation of this dictionary, whereby the saving of signals would be immense, as for instance, all words of three letters (or less), besides a great number of the more common words of more letters, might be assigned numbers between ten and 1000, whereby the bulk of messages would be susceptible of transmission by combinations of three symbols only—by "telegraphic three-lettered words" so to speak. Nearly, if not actually, the whole of the remaining words of the language might be assigned numbers from 1000 to 10,000,

and might thus be transmitted by "telegraphic four-lettered words."

As Arabic numbers are universally recognized in Europe, such a system would obviate the principal inconvenience of foreign telegraphy; for each nation and language might have its own dictionary; and since there would be less risk of error in the actual transmission and receipt of a message by the telegraph officials when once it was converted into telegraphic language, so also would there be greater control over the conversion and reconversion, in the hands of the sender and receiver.

Since there is no reason why certain numbers—say those from ten to thirty-six—should not be assigned to the letters of the alphabet, the proposed system does not forbid or interfere with the use of cipher, or with the transmission of words or names omitted in the dictionary, or newly coined, or wrongly spelt, or otherwise unrepresented.

The scheme is a perfectly *feasible* one. An ordinary octavo page of the dictionary might contain 200 words, so that 5 to 10 pages would contain the bulk of common short words, 50 to 100 would contain nearly the whole language; while an ordinary octavo volume of 500 pages would contain all that the ingenuity of the compiler could find to put into it.

No attempt is here made at a complete enumeration of all the advantages which such a codification would possess, nor indeed to enter fully into the many bearings of the question. It is sufficient for my present purpose to point out the enormous advantage of signalling by *numbers* instead of by *letters*.

I append rough data for comparison with the estimates I have made above of the use of words and letters.

"A well educated man in England, who has been at a public school and at the university, who reads his Bible, his Shakespeare, the *Times*, and all the books in Mudie's library, seldom uses more than 3,000 or 4,000 words* in actual conversation. Actual thinkers and close reasoners, who avoid vague and general expressions, and wait till they find a word that exactly fits their meaning, employ a larger stock, and eloquent speakers may rise to the command of 10,000."—*Max Müller's Lectures*, p. 254.

"Shakespeare," he says, "uses about 15,000 (a greater

* It is not quite clear from the context what is to be understood by the term "word" as here used. It probably excludes inflectional forms. If so, then, considering that most substantives have one, most verbs three, inflections, it will be necessary to double the estimates here made, to accord with my use of the term. But this will not affect the broad question of the advantages of codification materially.

number than any other writer), Milton about 8,000; while the Old Testament contains but 5,642 words."

In the *Times* of the 12th November, 1866, the usual telegram column furnishes the following estimate of the number of letters per word:—

Words of	1	letter	1	giving	1	letter
„	2	letters	37	„	74	letters
„	3	„	48	„	144	„
„	4	„	30	„	120	„
„	5	„	9*	„	45	„
„	6	„	23	„	138	„
„	7	„	14	„	98	„
„	8	„	17	„	136	„
„	9	or more	21	„ say	210	„
Total	200	words	containing		966	letters
			Average		4·8	„

* The paucity of five lettered words is not unworthy of note. It possibly is due to the step from monosyllabic to bisyllabic utterance.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY G. M. WHIPPLE.

1866. Day of Month.	Reduced to mean of day. Barometer, corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Temperature of Air. Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	At 9·30 A.M., 2·30 P.M., and 5 P.M., respectively. Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°	0—10		inches.
Oct. 1	30·062	55·0	53·5	·95	·442	60·2	53·1	7·1	8, 10, 9	NE, NE, N.	0·000
„ 2	29·988	57·0	56·0	·97	·473	61·7	52·8	8·9	10, 10, 8	NNE, ENE, NNW.	·000
„ 3	30·051	60·8	56·9	·87	·537	66·7	55·2	11·5	2, 10, 3	—, NNE, N by W.	·000
„ 4	30·089	56·3	56·2	·99	·462	60·8	55·1	5·7	10, 10, 10	NNW, N by W, N.	·000
„ 5	30·288	53·5	51·1	·92	·420	57·0	53·3	3·7	10, 10, 10	NNW, N by E, NNE.	·000
„ 6	30·452	55·5	53·8	·94	·450	59·8	53·5	6·3	10, 10, 10	NE by N, N, NNW.	·000
„ 7	...	...	...	...	...	61·7	55·2	6·5	...	...	·000
„ 8	30·341	56·6	50·4	·81	·467	64·1	46·7	17·4	9, 0, 1	NE by N, E, ENE.	·000
„ 9	30·190	53·3	47·0	·81	·417	59·3	51·7	7·6	9, 8, 8	E by N, ENE, ENE.	·000
„ 10	30·035	53·3	45·6	·77	·417	58·4	50·5	7·9	9, 7, 9	E, E, E by N.	·000
„ 11	30·030	52·5	45·8	·79	·406	56·3	48·7	7·6	9, 10, 8	ENE, NE by E, ENE.	·000
„ 12	29·985	51·6	47·6	·87	·394	57·6	45·8	11·8	9, 9, 3	NE, E, E.	·000
„ 13	29·915	47·0	42·3	·85	·337	55·9	35·8	20·1	10, 1, 9	—, S, SSW.	·000
„ 14	...	...	...	...	...	54·2	40·3	13·9	...	...	·037
„ 15	30·153	47·1	38·5	·74	·338	53·3	35·2	18·1	4, 3, 10	SW by S, W by N, NW by W.	·003
„ 16	30·197	42·6	38·0	·85	·289	51·6	31·0	20·6	0, 7, 0	—, NE, NE.	·000
„ 17	30·018	49·6	39·7	·71	·368	55·1	38·7	16·4	0, 8, 3	ESE, E by S, E by S.	·000
„ 18	29·864	49·2	50·1	1·00	·363	53·1	44·6	8·5	10, 10, 10	E by S, E, E.	·177
„ 19	30·043	58·1	56·7	·95	·491	64·5	48·6	15·9	10, 8, 7	S, S, S by E.	·573
„ 20	30·172	56·4	56·3	·99	·463	61·0	52·6	8·4	9, 10, 10	E by N, E by N, E.	·010
„ 21	...	...	...	...	...	62·1	51·7	10·4	...	...	·032
„ 22	29·918	53·6	53·2	·98	·422	62·2	51·3	10·9	10, 10, 10	ENE, W, W by N.	·010
„ 23	30·129	52·4	51·4	·96	·405	57·8	38·6	9·2	9, 10, 10	SW, SW, SW by W.	·280
„ 24	29·857	52·0	47·2	·85	·400	58·5	47·0	11·5	5, 7, 6	S, SW, S.	·000
„ 25	29·666	42·9	41·0	·93	·292	49·1	44·1	5·0	10, 10, 10	N by W, NW by W, N.	·320
„ 26	29·930	47·2	42·7	·86	·339	52·1	43·8	8·3	7, 2, 7	N by W, NNE, NW by N.	·084
„ 27	30·008	43·5	41·5	·93	·298	51·3	31·1	20·2	10, 4, 10	—, SSW, S.	·000
„ 28	...	...	...	...	...	54·0	37·2	16·8	...	...	·057
„ 29	30·354	44·4	40·3	·87	·308	52·7	32·7	20·0	1, 10, 10	WSW, S by W, SW.	·000
„ 30	29·815	52·5	49·9	·91	·406	56·8	40·9	15·9	10, 10, 9	SW by S, WSW, W.	·010
„ 31	30·098	45·2	40·0	·84	·316	52·5	36·8	15·7	0, 1, 1	WSW, W, WSW.	·040
Daily Means.	30·061	51·4	47·9	·88	·397	...	...	11·8	...	...	1·632

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—October, 1866.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly means.
Hour.																																
A.M. 12	10	7	3	6	6	10	5	8	9	7	12	5	1	3	5	1	9	11		9				4	13	9	1	5	4	16	7	6·9
1	13	6	4	9	6	5	5	8	9	8	12	2	1	4	6	1	6	11		9				2	6	11	1	3	4	14	6	6·4
2	8	7	1	6	9	3	5	8	7	9	12	2	3	3	5	1	6	12		10				4	5	10	2	5	4	17	6	6·3
3	9	6	1	11	9	4	4	8	8	7	13	4	4	3	4	2	8	13		11				3	2	10	1	7	4	16	6	6·6
4	10	8	2	5	9	6	4	9	10	12	13	3	3	4	2	2	7	12		9				5	3	11	1	6	5	17	4	6·6
5	10	7	1	10	8	7	4	10	12	11	11	1	2	2	2	2	9	8		6				5	3	10	2	5	4	19	4	6·5
6	13	6	2	6	6	7	5	8	13	12	11	2	1	4	3	1	8	10		6				5	3	9	2	8	5	19	3	6·6
7	15	8	3	5	8	9	7	11	13	11	11	1	3	2	1	2	9	9		5				7	4	10	1	7	5	18	4	7·0
8	13	9	4	5	7	10	8	10	12	15	12	4	3	2	1	1	13	11		6				10	7	8	2	15	5	25	4	8·2
9	11	8	2	5	8	12	7	10	13	15	14	4	3	2	5	1	13	11		5				11	4	10	2	16	6	25	4	8·4
10	10	8	1	6	9	8	11	14	17	12	12	6	4	3	5	3	24		13		195	138	127	12	5	12	2	18	6	24	4	9·6
11	11	9	4	6	8	9	12	13	17	15	13	7	3	5	5	4	24		13					16	6	11	7	20	11	29	3	10·8
12	13	7	3	6	9	10	13	15	16	19	18	9	3	9	4	6	21		11					19	7	13	3	20	12	24	6	11·4
P.M. 1	10	8	3	5	8	7	11	16	15	17	15	7	3	9	6	5	21		13					18	8	11	3	23	10	20	7	10·7
2	9	5	6	4	8	7	10	16	16	14	16	10	3	8	7	6	17		11				29	17	7	10	3	17	13	16	5	10·0
3	9	6	5	6	8	7	11	13	11	11	13	5	1	9	6	7	15		9					14	7	8	2	16	11	14	7	8·9
4	6	4	4	5	7	7	10	8	13	14	13	6	2	14	4	4	12		9					12	6	7	4	11	9	10	5	7·9
5	7	3	5	5	9	5	10	8	13	16	12	2	1	16	1	3	13		8				6	10	6	2	5	9	9	11	5	7·7
6	7	1	6	4	5	7	6	10	13	14	12	0	2	14	2	6	14		8				8	9	6	6	4	8	9	10	5	7·5
7	9	2	5	3	4	9	8	9	12	18	10	2	1	10	2	7	11		7				7	8	7	7	3	11	8	11	5	7·5
8	9	4	3	4	3	9	10	7	13	14	9	2	3	15	1	7	10		10				5	8	6	1	3	6	10	9	6	7·2
9	8	5	6	5	6	8	9	9	11	13	9	1	4	12	1	8	10	217	8				6	9	5	2	3	4	12	8	4	7·2
10	8	5	3	3	7	9	10	9	9	13	5	0	2	13	3	8	10		10				4	10	7	1	2	4	13	7	5	6·9
11	6	3	6	4	9	6	9	10	7	13	5	4	2	8	0	7	10		9				5	11	9	1	4	5	14	9	3	6·9
12																																
Total Daily Movement.	234	142	83	134	176	181	194	247	289	310	283	89	58	174	81	95	300	464						229	142	190	63	249	193	388	118	7·7

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1866.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M. respectively.		
			Calculated.								
Day of Month.	Barometer corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°	0—10		inches.
Nov. 1	29·945	51·7	47·5	·87	·395	55·0	39·7	15·3	10, 10, 10	W by S, W by S, S.	0·000
„ 2	29·790	54·4	52·0	·92	·433	59·5	47·6	11·9	10, 9, 10	S by W, SW, SSW.	·023
„ 3	29·636	52·2	49·3	·90	·402	57·6	50·5	7·1	10, 8, 8	SSW, SW, SW by S.	·012
„ 4	...	...	...	...	...	54·5	37·4	17·1	...	... ...	·053
„ 5	29·917	54·0	50·8	·90	·427	57·7	45·5	12·2	9, 10, 10	SW by S, WSW, WSW.	·005
„ 6	30·075	52·4	47·2	·84	·405	57·2	50·5	6·7	0, 4, 8	WSW, W, W.	·000
„ 7	30·051	52·6	47·5	·84	·408	55·5	43·7	11·8	10, 9, 10	W, SW by W, W by S.	·000
„ 8	29·805	53·7	49·8	·88	·423	57·9	51·3	6·6	8, 10, 10	SW, SW by W, SW.	·010
„ 9	29·890	44·1	36·4	·76	·305	—	38·0	—	0, 4, 0	N, W by N, WSW.	·315
„ 10	30·120	34·0	34·2	1·00	·214	55·8	29·6	26·2	10, 10, —	—, —, —.	·000
„ 11	...	...	...	...	...	56·6	31·7	24·9	...	... ...	·300
„ 12	29·882	48·5	45·5	·90	·354	58·6	38·0	20·6	10, 10, 10	WSW, SW by S, S.	·000
„ 13	29·625	52·0	45·4	·80	·399	56·9	47·3	9·6	10, 7, 2	W by S, W, W.	·134
„ 14	29·982	44·5	34·0	·69	·309	49·7	41·5	8·2	0, 4, 4	W by N, W by N, W.	·040
„ 15	30·019	44·5	39·4	·84	·309	47·7	33·4	14·3	9, 10 10	SW, S by W, SSW.	·000
„ 16	29·288	51·9	45·9	·81	·398	56·6	42·7	13·9	10, 5, 4	SW by S, W by S, W.	·017
„ 17	30·256	35·3	25·0	·69	·224	40·3	32·6	7·7	0, 1, 4	SW, NW by N, NW.	·010
„ 18	...	...	...	...	...	52·7	31·3	21·4	...	... ...	·230
„ 19	29·946	35·1	20·8	·60	·222	38·8	35·0	3·8	3, 0, 0	NW, NW, NW by W.	·090
„ 20	30·185	32·8	24·7	·75	·205	37·9	29·0	8·9	0, 0, 0	NW by W, NW by W, W.	·000
„ 21	30·101	38·6	34·6	·87	·251	44·6	25·9	18·7	7, 0, 7	WSW, WNW, SW by W.	·000
„ 22	30·200	42·8	40·8	·93	·291	45·8	33·9	11·9	10, 10, 10	SW, W by S, WSW.	·000
„ 23	29·777	46·0	43·2	·91	·325	49·6	41·1	8·5	10, 10, 10	SW, W by S, WSW.	·036
„ 24	29·911	41·1	37·2	·87	·274	45·5	37·1	8·4	1, 10, 10	W, SW by W, SW by W.	—
„ 25	...	...	...	...	...	48·1	39·2	8·9	...	... ...	·000
„ 26	29·977	42·9	34·8	·75	·292	48·6	36·0	12·6	10, 2, 10	NW, NW, WSW.	·000
„ 27	29·968	45·6	37·3	·75	·321	49·5	41·5	8·0	9, 8, 1	NW by W, NW, NW.	·000
„ 28	30·266	38·3	35·1	·89	·249	45·5	30·4	15·1	0, 0, 0	SSW, W, W by S.	·000
„ 29	30·259	40·9	36·1	·85	·273	46·9	29·8	17·1	7, 1, 10	—, S by E, E.	·000
„ 30	30·054	35·3	27·7	·76	·224	40·1	30·6	9·5	0, 0, 0	E, E, E by N.	·000
Daily Means.	29·959	44·8	39·3	·83	·320	...	...	12·6	...	... ...	1·275

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—Nov., 1866.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Hourly Means.
Hour.																															
12	3	5	4	2	8	13	7	10	7	3	24	5	21	20	8	19	17	7	10	15	7	3	8	15	15	11	13	5	1	14	10·0
1	7	2	6	4	11	12	8	11	7	3	25	5	21	22	7	20	16	12	10	12	3	4	5	16	15	11	15	4	1	15	10·3
2	9	2	8	2	12	11	7	11	9	3	26	3	23	18	5	17	13	8	8	10	5	4	6	18	15	11	12	5	1	20	10·0
3	8	3	10	3	14	11	12	11	7	1	27	5	22	19	6	19	12	10	8	11	5	6	7	15	15	13	11	4	3	15	10·4
4	6	2	10	3	15	11	11	13	9	2	20	5	21	19	6	20	10	17	14	9	7	4	7	13	16	12	14	4	2	7	10·3
5	11	1	7	6	14	12	9	15	10	1	15	5	22	19	6	20	12	16	12	8	6	4	6	8	13	7	10	4	1	3	9·4
6	8	5	10	6	13	10	13	15	10	1	17	5	23	20	7	22	9	17	11	8	6	1	7	9	12	8	18	4	2	9	10·2
7	8	6	11	7	13	10	13	16	10	2	18	7	24	21	7	21	11	20	12	9	7	4	11	9	15	12	18	4	2	11	11·3
8	8	6	14	5	15	9	18	17	11	2	21	4	26	24	6	22	10	19	15	5	7	6	13	6	13	15	15	4	1	13	11·7
9	8	5	14	7	18	8	17	24	15	1	18	6	17	25	8	22	10	18	13	5	7	5	12	8	11	15	14	4	1	15	11·7
10	12	11	17	11	20	16	19	24	18	1	15	7	10	23	10	22	10	20	16	9	10	7	15	12	17	19	17	5	0	12	13·5
11	13	14	20	11	21	16	24	26	20	2	14	10	12	24	14	21	11	17	17	9	12	5	30	10	20	20	19	5	2	14	15·1
12	13	15	15	14	23	15	19	23	19	2	19	10	16	23	13	23	12	18	19	10	14	5	14	11	21	18	17	4	2	12	14·7
1	8	12	9	13	24	16	18	25	15	2	19	7	15	20	11	25	12	17	17	11	13	6	15	7	16	13	18	4	6	12	13·3
2	9	10	13	14	22	15	17	24	15	3	17	9	19	18	12	25	10	17	17	10	12	6	14	5	17	14	13	4	6	12	13·3
3	6	11	14	11	17	11	17	23	10	2	12	10	18	13	15	25	7	14	14	5	6	5	16	7	20	8	10	4	4	9	11·4
4	6	9	10	15	18	9	13	23	8	2	9	10	16	12	17	24	5	13	12	4	5	5	16	6	14	9	8	2	2	9	10·6
5	5	8	8	12	15	9	12	22	6	3	7	7	11	9	15	20	5	6	10	6	6	4	20	10	15	6	6	2	4	12	9·2
6	5	6	6	12	15	8	11	22	4	9	5	9	13	9	17	20	3	6	10	7	5	4	15	7	12	6	8	2	3	7	8·9
7	9	5	4	13	13	9	13	17	17	10	7	14	11	9	15	25	7	8	10	5	4	4	17	12	13	8	8	2	4	11	10·1
8	6	9	4	14	12	8	14	7	6	8	7	19	10	11	15	23	5	7	10	4	3	4	13	10	11	6	8	2	4	6	9·2
9	4	7	3	12	12	5	12	11	6	14	6	20	11	9	16	24	3	7	13	4	4	4	17	11	10	7	6	1	6	5	9·0
10	8	5	4	11	12	6	11	13	4	22	8	21	13	9	17	20	2	9	14	5	3	5	18	18	10	10	6	1	12	5	9·9
11	3	5	4	11	11	7	9	5	4	20	7	22	15	9	20	23	4	8	16	4	4	3	18	16	9	13	6	1	8	5	9·7
12																															
Total Daily Movement.	178	164	225	218	368	257	324	408	247	119	363	225	410	407	273	522	216	311	308	185	162	108	320	259	342	272	290	81	78	253	10·9

Rain—Read at 9·30 A.M.	Inches.
1	0·000
2	·023
3	·012
4	·053
5	·005
6	·000
7	·000
8	·010
9	·315
10	·000
11	·300
12	·000
13	·134
14	·040
15	·000
16	·017
17	·010
18	·220
19	·090
20	·000
21	·000
22	·000
23	·036
24	—
25	·000
26	·000
27	·000
28	·000
29	·000
30	·000
	1·275

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1866. Day of Month.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively.		Rain—read at 9·30 A.M.
			Calculated.								
	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°	0—10		inches.
Dec. 1	29·782	33·4	28·1	·83	·209	35·6	27·6	8·0	10, 10, 10	E, E by N, E.	0·000
„ 2	...	...	...	...	...	47·0	33·1	13·9	...	...	·183
„ 3	29·782	49·5	47·5	·93	·367	52·6	33·8	18·8	9, 10, 10	SW by S, SW, SW.	·062
„ 4	29·717	53·7	51·1	·92	·423	55·4	46·5	8·9	10, 10, 10	SW, SW by W, SW.	·162
„ 5	29·778	53·1	53·0	·99	·415	54·6	52·7	1·9	10, 10, 10	SW by S, SW, SW.	·110
„ 6	29·746	52·5	50·0	·92	·406	56·6	46·5	10·1	10, 10, 10	S by W, SSW, SW.	·419
„ 7	29·520	46·6	39·3	·78	·332	49·3	47·9	1·4	10, 7, 2	SW by S, W by S, WSW.	·036
„ 8	30·326	38·8	32·0	·79	·253	44·1	36·0	8·1	0, 2, 0	W, WNW, W.	·019
„ 9	...	...	...	...	...	53·6	24·3	29·3	...	...	·010
„ 10	30·097	44·7	39·3	·83	·311	48·9	39·4	9·5	4, 7, 1	NW, NW by W, NW.	·064
„ 11	30·302	34·7	34·6	·99	·219	—	30·0	—	10, 9, 10	N by E, ENE, E by N.	·020
„ 12	29·793	52·1	48·3	·88	·401	53·4	33·0	20·4	10, 9, 10	W, W, W by S.	·140
„ 13	29·432	50·7	46·7	·87	·382	55·8	47·3	8·5	10, 10, 2	SW by S, W by S, W.	·022
„ 14	29·457	43·7	38·3	·83	·300	48·5	39·9	8·6	0, 8, 8	WSW, W, SW.	·189
„ 15	29·418	45·6	41·5	·87	·321	50·8	36·0	14·8	10, 10, 9	SSE, W, W.	·000
„ 16	...	...	...	...	...	48·3	42·1	6·2	...	...	·150
„ 17	30·211	47·0	45·9	·96	·337	51·6	34·9	16·7	10, 10, 10	S by W, SW by W, SW by S.	·000
„ 18	30·260	50·4	45·7	·85	·378	53·7	41·3	12·4	10, 10, 1	SW, WSW, SW by S.	·000
„ 19	30·356	44·8	35·8	·73	·312	49·7	45·1	4·6	0, 1, 0	W by N, W by N, N.	·000
„ 20	30·465	36·1	34·7	·95	·230	36·9	25·4	11·5	10, 8, 10	—, —, —.	·000
„ 21	30·318	37·1	34·6	·92	·238	39·8	26·1	13·7	10, 1, 2	WSW, SW by W, SW.	·000
„ 22	30·416	57·7	37·4	·99	·244	42·3	28·6	13·7	10, 10, 10	SW, S, S.	·003
„ 23	...	...	...	...	...	44·8	35·2	9·6	...	...	·010
„ 24	30·299	39·8	39·1	·97	·262	42·6	38·5	4·1	10, 10, 10	SSW, S, S.	·000
„ 25	...	...	...	...	...	47.5	34·4	13·1	...	...	·000
„ 26	29·976	45·9	43·2	·91	·324	49·4	38·5	10·9	10, 5, 5	SSW, SSW, SW by S.	·005
„ 27	29·857	44·6	36·6	·76	·310	47·7	43·3	4·4	1, 9, 1	W, W, W.	·067
„ 28	29·987	48·1	40·4	·77	·350	51·7	43·6	8·1	6, 9, 10	WSW, W, WNW.	·000
„ 29	29·671	48·2	42·0	·81	·351	51·3	44·3	7·0	3, 10, 9	SW, W, W by S.	·000
„ 30	...	...	...	...	...	42·5	34·6	7·9	...	...	·013
„ 31	29·299	31·0	28·6	·92	·192	33·5	26·6	6·9	3, 7, 2	SW by W, —, —.	·013
Daily Means.	29·930	44·3	40·5	·88	·314	...	...	10·4	...	...	1·697

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—December, 1866.

Day.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means
Hour.																																	
12		5	9	20	24	19	7	26	10	0	17	4	4	18	10	8	18	4	8	19	1	6	1	2	5	1	18	34	10	16	16	4	11·1
1	A.M.	5	5	25	21	14	9	26	8	1	17	1	5	16	10	9	18	4	9	20	2	7	0	2	5	3	19	25	11	16	14	6	10·8
2	A.M.	5	3	20	23	13	8	21	10	2	19	2	6	20	12	7	17	5	11	20	1	7	0	1	4	2	17	21	11	12	13	5	10·3
3	A.M.	4	2	13	24	14	7	22	9	3	13	2	6	22	14	8	22	3	12	21	1	5	1	2	2	3	19	23	11	12	12	5	10·2
4	A.M.	2	5	10	27	13	8	20	10	5	11	1	10	23	13	7	17	2	12	19	1	4	1	4	1	2	15	25	11	15	12	6	10·1
5	A.M.	4	5	10	24	14	5	20	6	5	12	2	10	19	11	5	17	2	13	19	0	4	1	3	1	1	13	20	12	12	12	5	9·2
6	A.M.	6	5	10	26	16	8	24	9	5	11	2	10	21	9	6	21	2	13	16	0	3	1	4	3	4	11	18	12	13	14	4	9·9
7	A.M.	9	6	13	26	14	7	22	9	6	11	4	11	20	9	5	22	1	10	17	0	2	0	3	2	2	9	19	10	10	14	4	9·6
8	A.M.	8	7	11	27	15	6	23	7	10	9	4	18	22	9	4	13	3	10	10	0	2	0	4	7	4	6	15	11	15	12	4	9·5
9	A.M.	10	7	17	25	18	6	19	5	11	11	3	12	20	10	6	12	7	10	10	0	3	1	3	9	5	17	16	12	12	14	3	10·1
10	A.M.	10	7	19	22	18	14	23	10	16	9	6	17	22	12	9	13	8	12	11	1	6	1	4	9	7	10	19	11	19	16	2	11·7
11	A.M.	8	8	22	26	25	21	23	10	21	10	1	19	26	11	13	15	7	11	12	2	5	3	5	6	5	8	18	17	18	18	4	12·9
12	A.M.	10	7	25	25	24	23	26	10	25	13	2	17	25	10	10	15	12	14	14	1	4	1	7	6	10	10	12	21	17	18	3	13·5
1	P.M.	10	5	24	27	20	25	25	10	23	10	2	21	26	13	8	12	10	16	10	1	5	2	5	5	10	14	19	21	17	20	0	13·4
2	P.M.	10	4	21	27	21	25	26	8	25	9	1	18	22	16	9	9	12	19	7	1	6	3	7	4	12	13	17	22	19	19	2	12·3
3	P.M.	8	3	21	27	19	25	25	5	25	4	3	16	19	10	18	47	8	16	4	2	4	1	4	8	12	14	17	19	20	15	1	12·3
4	P.M.	10	4	23	26	16	28	26	5	27	4	2	16	16	10	26	6	10	16	4	1	3	1	4	7	14	12	17	17	23	14	0	12·5
5	P.M.	7	5	27	27	10	30	21	4	26	4	3	15	11	10	21	6	7	10	2	2	3	1	4	6	14	14	12	18	19	10	1	11·3
6	P.M.	8	12	29	30	13	30	23	2	27	3	4	13	11	12	17	7	9	10	3	1	2	1	5	3	12	21	14	18	23	9	1	11·6
7	P.M.	9	15	26	29	6	31	19	2	25	2	2	10	10	12	20	7	10	12	5	1	2	1	7	2	15	22	15	15	23	9	0	11·8
8	P.M.	6	14	25	24	4	32	12	1	26	4	1	10	12	11	17	5	7	8	5	2	2	1	2	1	13	24	15	14	23	7	1	10·6
9	P.M.	6	10	18	21	10	34	13	2	25	3	1	10	12	11	20	5	10	14	1	3	2	1	4	1	14	33	14	15	19	7	1	11·0
10	P.M.	9	13	26	21	8	33	12	2	21	4	1	11	11	8	20	4	11	16	2	6	3	1	8	2	18	32	14	14	19	5	2	11·5
11	P.M.	7	13	22	21	7	29	9	1	17	4	2	16	13	8	17	4	12	20	2	3	2	2	6	1	18	35	15	12	15	7	4	11·1
12	P.M.																																
Total Daily Movement.		176	175	477	600	351	451	506	155	377	214	56	301	437	261	290	292	166	302	253	33	92	26	100	100	201	406	434	345	407	307	168	11·2

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RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

MONTHLY AND ANNUAL MEANS FOR THE YEAR 1866.

Month.	Barometer, corrected to temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Daily Range.	Total Fall of Rain.	Month.	Barometer, corrected to temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Daily Range.	Total Fall of Rain.
	inches.	°	°		inch.	°	inches.		inches.	°	°		inch.	°	inches.
January	29·860	42·7	37·9	·85	·294	9·7	3·384	August ...	29·776	58·4	50·8	·74	·498	16·2	2·435
February ...	29·700	41·8	35·9	·81	·286	10·5	3·718	September.	29·756	55·2	49·6	·83	·447	12·4	3·588
March.....	29·643	40·1	34·0	·81	·271	11·6	1·150	October ...	30·061	51·4	47·9	·88	·397	11·8	1·633
April	29·866	47·3	40·1	·80	·348	14·5	1·807	November.	29·959	44·8	39·3	·83	·320	12·6	1·275
May.....	29·941	50·2	38·4	·67	·382	17·9	1·319	December..	29·930	44·3	40·5	·88	·314	10·4	1·697
June	29·909	59·4	52·4	·76	·521	18·3	3·161								
July.....	29·914	61·1	51·4	·73	·551	17·5	1·930	Mean	29·860	49·7	42·8	·80	·386	13·6	27·097

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

TABLE SHOWING THE MEAN VELOCITY OF THE WIND FOR EACH HOUR OF THE DAY IN THE DIFFERENT MONTHS OF THE YEAR 1866 (IN MILES PER HOUR).

	A. M.												P. M.												
Hour.	12 to 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	to 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	Mean.
Jan.	13·0	12·6	13·3	13·5	13·9	13·4	13·7	14·6	14·9	15·6	16·0	17·3	18·3	17·4	16·7	14·6	13·4	13·0	13·7	13·9	13·8	13·7	14·7	12·4	14·7
Feb.....	12·1	11·5	10·9	12·0	11·8	11·2	11·1	11·2	12·3	14·1	15·9	16·7	19·8	19·6	18·5	17·6	14·0	13·7	13·8	12·8	12·7	13·2	11·4		13·4
March ...	8·2	9·0	9·0	8·6	8·7	8·9	9·6	9·9	10·9	12·6	14·7	15·0	16·7	16·6	15·6	15·2	15·0	11·9	11·9	10·2	9·5	9·4	9·7	8·9	11·5
April	9·3	9·0	8·6	8·9	9·1	9·2	9·7	11·5	13·4	14·1	16·0	16·1	17·1	17·2	17·2	16·7	17·0	14·7	13·3	11·8	11·6	10·9	11·7	10·1	12·9
May.....	8·2	8·0	7·4	7·0	7·4	7·2	8·9	11·1	11·4	12·4	12·8	12·7	13·0	14·6	14·0	14·8	14·8	13·5	12·6	11·8	9·4	8·5	8·7	7·9	10·8
June.....	6·8	6·0	5·8	5·8	6·0	6·3	7·8	8·6	9·6	10·0	12·9	13·2	13·9	13·6	13·7	12·8	13·9	11·9	11·2	9·2	8·4	7·4	7·6	6·4	9·4
July.....	6·4	6·7	6·8	6·3	6·2	6·2	7·8	9·5	10·2	10·2	11·3	11·2	12·2	12·5	12·6	12·6	12·2	10·7	10·4	9·3	7·8	6·8	7·2	6·1	9·1
August...	8·2	8·0	7·3	7·3	7·0	6·5	7·6	8·6	9·4	10·3	11·1	10·8	11·8	11·2	11·9	12·8	12·6	11·6	10·2	9·9	8·6	8·2	8·0	7·7	9·4
Sept. ...	9·9	9·6	9·5	9·4	8·6	8·5	9·3	10·4	12.0	13·4	14·0	14·4	15·5	14·3	13·5	13·6	14·0	11·7	10·4	10·7	10·9	9·8	10·4	10·4	10·9
Oct.	6·9	6·4	6·3	6·6	6·6	6·5	6·6	7·0	8·2	8·4	9.6	10·8	11·4	10·7	10·0	8·9	7·9	7·7	7·5	7·5	7·2	7·2	6·9	6·9	7·7
Nov.....	10·0	10.3	10·0	10·4	10·3	9·4	10·2	11.3	11·7	11·7	13·5	15·1	14·7	13·3	13·3	11·4	10·6	9·2	8·9	10·1	9·2	9·0	9·9	9·7	10·9
Dec.	11·1	10·8	10·3	10·2	10·1	9.2	9·9	9·6	9·5	10·1	11·7	12·9	13·5	13·4	13·3	12·3	12·5	11·3	11·6	11·8	10·6	11·0	11·5	11·1	11·2
Mean.....	9·2	9·0	8·8	8·8	8·8	8·4	9·3	9·4	11·1	11·9	13·3	13·9	14·8	14·5	14·2	13·6	13·4	11·8	11·3	10·9	10·0	9·5	9·9	9·9	11·0

LIGHT SPOTS IN THE LUNAR NIGHT.—THE CRATER LINNE.—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

AFTER a long interval, we return to the study of some of the details of the surface of our satellite. In following the arrangement of Beer and Mädler we have last described the Lunar *Alps* (19 in our Index-Map) and should next in order proceed to the W. extremity of the great *Mare Imbrium* (I); but that we ought not to pass without remark the site of a singular luminous appearance described by Schröter with much precision; of which, as might have been expected, no notice whatever has been taken by Beer and Mädler, but which we think of sufficient interest to lay at some length before our readers, together with some other instances of the same nature.

The earliest mention of any luminosity on the unenlightened part of the moon seems to have been that of Sir W. Herschel, who perceived in 1783 and 1787, three patches of feeble light, which he considered to be volcanoes in eruption. As there was much in favour of the possibility of such an event, and nothing to contravene it, the assertion was generally received. Schröter, who had in 1784 independently noticed with a 4-foot Newtonian, made by Sir W. Herschel, the visibility of the brilliant crater *Aristarchus* (43) on the dark side of the moon, and had perceived that it shone simply by the reflection of the earth-light, was thus induced to make a careful revision of many parts of the unenlightened hemisphere, when sufficiently in front of the earth to receive a considerable share of our reflected rays; and his attention was especially directed to the neighbourhood of the great wall-plain *Plato* (38)—a little E. of the district we have last described—by the circumstance that in Jan. 1788, Fischer at Mannheim had perceived a feeble illumination which he had, erroneously as it seems, referred to that region. Schröter had no difficulty in recognizing three phosphorescent spots; measurement and allineation enabled him readily to identify them with the large and very luminous craters *Aristarchus* (43), *Manilius* (24), and *Menelaus* (15);* and no reasonable doubt remained that these were the three supposed volcanoes of Herschel. But nothing was perceptible in the vicinity of *Plato*. In other directions, towards the E. limb

* B. and M. have preferred, for what reason does not appear, *Aristarchus*, *Copernicus* (30), and *Kepler* (41). The idea of these eruptions, however, was not at once abandoned. Fallows, who died at the Cape in 1831, believed that he had seen them.

of the moon, he picked up from time to time faint glowing specks, and was at much pains to identify them, and to detect the cause of their apparent variations, and after a first precipitate inference of volcanic activity, was at length led to the important conclusion, that portions of the lunar surface subtending only a few seconds, may be either entirely inconspicuous, or faintly luminous, or strongly glittering, according to the angle of illumination, and that consequently a distinct luminosity may be sometimes perceived in a spot in the earth-shine, which has but a dusky aspect even under the solar rays falling on it at a different angle. The effect therefore of the earth's reflection is directly comparable only with the aspect of the full moon; and so far, there would be no reason to ascribe any other origin than the reflection of the earth-shine, to the generality of the luminous specks visible on the dark hemisphere. And in this conclusion Bode and other astronomers acquiesced. There were, however, some residual phenomena not thus entirely explained, and Schröter thought that not only had atmospheric differences to be allowed for in the usual way, but also their indirect action in influencing the reflective power of the earth, and that beyond this, there must be some modifying cause on the surface of the moon or in her atmosphere, to account for certain variations which he perceived. Without anticipating some of his observations on the neighbourhood of the E. limb, we may give his example, that after a familiar acquaintance of two years with the aspect of *Manilius* and *Menelaus* under doubly reflected light, when he usually found *Menelaus* considerably the larger and brighter of the two, in a subsequent set of six observations in 1790, *Manilius* appeared to him not only larger, but at least as bright, and in some instances actually brighter than its neighbour. As to the latter part of these inferences, astronomers may entertain different opinions; and some would claim an allowance for more practised ocular judgment, such as has been known to influence progressive estimates of the brightness of nebulæ or the distances of double stars. But there is always something interesting and instructive in following the mental processes of any clear and consecutive thinker, who is not afraid of describing his own successive impressions or of retracting his too hasty conclusions. And besides this, facts are often gradually evolved out of seeming confusion and misapprehension, and sometimes what has been suffered to drop through, in hastily grasping at some tempting simplicity of explanation, has been subsequently found essential to the full apprehension of a truth more complex than it may have appeared. It is not impossible that the present very interesting investigation into the state of the crater Linné, which we owe to the great observer Julius Schmidt of Athens, may lead to a

review of some of the neglected and perhaps undervalued speculations of Schröter.

However, we must now see what happened to this astronomer, 1788, Sept. 26, 4h. 25m. in the early morning, when he often rose to carry on his investigations, in the spirit of old Hevel's resolution, "As far as I am concerned, I will not suffer sleep to be so dear to me, that the investigation of so great a matter should not be dearer." It was 3¼ days before the new moon: the sky was so clear that the streaks of Tycho were distinctly visible in the dark side: and with a fine 7-foot Newtonian made by Herschel, and a power of 161, he examined the region of *Proclus* (12), as the second point in reflective power on the moon. Notwithstanding however its favourable position on the hemisphere, and its intensity in the full moon, he could not find a trace of it. The most probable explanation of this failure—the minute breadth of the ring, which is the only reflective part*—did not occur to him, and he was proceeding to scrutinize the neighbourhood of the N. limb, when he was struck all at once by the appearance of a small whitish spot of somewhat misty light, about 4″ or 5″ in diameter, like a star of the 5th mag. seen with the naked eye, which had a faintish radiating glimmer around it, and on a small scale looked much like the spot *Kepler* (41) as viewed on the enlightened side with a moderate power. To preclude any deception, he traversed several times the rest of the unenlightened disc, and recognized its features, as before, with much distinctness, but as soon as ever this N. part was brought into the field, again repeatedly found the same luminous spot, sometimes brighter, at others more faint, but always distinct, and in an unvaried position. Previous to an intended measurement with his projection machine† he estimated its place to be very near the edge of the dark *Mare Imbrium*, and about 1¼ to 1½ diameter, or 1′ 16″ to 1′ 20″ distant from a dark spot which he at once recognized as *Plato*.

This estimation he repeated and confirmed several times while he kept constantly under review the other features of the dark disc. But now his spot was becoming at intervals indistinct—then uncertain—and soon after totally disappeared. To obtain

* See Intellectual Observer, vii. 258.

† This was a simple measuring apparatus always used by him in selenography, and consisting of a board covered with white paper ruled in squares, and placed at a suitable distance, which was viewed with one eye, while the lunar surface was looked at with the other. A modification with circular discs, for measuring planets, has been already described. Intellectual Observer, viii. 458.

more light, as the object was sufficiently large, he changed his power for one of 95, but could only now and then perceive an extremely feeble and quite uncertain vestige of it, and after an observation of more than a quarter of an hour, he found it had entirely vanished. Nothing in our own atmosphere could have produced this luminosity, as during the course of nearly half an hour, it had kept its position unmoved, and after its disappearance *Manilius* and *Menelaus* and the other features of the dark side were as visible as before: it must therefore, he concluded, have been an actual development of light either upon the surface or in the atmosphere of the moon. On comparing its situation with a sketch of the vicinity taken some time before, he found that it concurred with the region of the lunar *Alps*, which he resolved to study with renewed energy. Here, Oct. 8, he perceived, just to the E. of the great peak of *Mont Blanc* (Int. Obs., ix. 63), and enclosed by the lower ridges of that mountain mass, a round, black, defined spot of 6″, like a crater without a ring, all lying in shade, which he never recollected to have seen before: and the measurement of whose position agreed, as nearly as could be expected, with his former estimate. The two following evenings it appeared as a very flat depression, of a darker grey than the *Mare*. Oct. 11, the grey was only that of the *Mare*, with a little central darkness, which, 13, had disappeared. 14 and 15, including the full moon, the same. Nov. 8, it was seen again as a round black crater-like hole, though the illumination and libration were nearly the same as on Oct. 9, when it was only dark grey. 20, though near the line of lunar sunset, and fully exposed to the solar rays, it appeared grey and flat. Dec. 11, the site appeared indistinct in the 4-foot reflector. He details these and many other observations at much length to strengthen his position that something more than mere difference of illumination was concerned in these variations. In this he may probably have been mistaken; a long smooth slope slightly inclined to the horizon would change its aspect so entirely from very trifling variations in the angle of light incident in one direction, and would be so little affected by corresponding variations of illumination from the opposite side, that, in connection with changes of libration, this cause alone might suffice for all his recorded phenomena; yet still they are instructive enough in their own way to deserve this passing notice: and had any regularly-formed crater since been visible upon the spot, we should have acknowledged an evident analogy with the processes now supposed to be in operation in the crater *Linné*. Subsequently (1789, Apr. 5), he was much struck by the discovery of a minute bright crater not more than 10″ or 12″ E. of the supposed dark opening, just where the furthest spur

of *Mont Blanc* in that direction sinks into the plain; and by finding another well-known crater (*Plato* K. of B. and M.), not quite so small, lying a little way out in the plain in the prolonged direction of the *Wedge-shaped Valley* (INT. OBS., ix. 61), not only somewhat enlarged, but doubled by the encroachment of a smaller companion on its S.E. side—a feature quite new to him, though he had drawn it twice under entirely dissimilar illumination, with the interval of a year. Besides this, though the weather was not favourable, several other very small objects were perceived for the first time within a short distance, while a known minute crater in the plain, S.E. of *Mont Blanc*, could scarcely be identified as such.* He was naturally much surprised at all this, in a spot which he had 16 times during half a year been scrutinizing under various illuminations with especial care; and while holding to his idea that many such apparent changes were connected with variations in a lunar atmosphere, he thought that on the whole, taken in connection with the luminous appearance in this very region, some eruptive action might probably be indicated.

The site of this phosphorescence, so to speak, naturally attracted his continued attention; but never could he trace a vestige of it again. He waited for the time when the moon should occupy a corresponding position, which happened more than a year afterwards, 1789, Oct. 15. The circumstances were very favourable: the old features were all discernible, and even a very faint shining could be made out on the site of *Proclus*, but where the little star-like speck had vanished, the gazing of an hour brought out so feeble a trace of a glimmering point at times, that it was quite uncertain, and probably only the illusory result of an over-taxed vision. Had the little crater at the E. foot of *Mont Blanc* been subsequently found of larger size, he might, he says, have referred this flicker to the closing scene of an eruption there. But in this he would have been mistaken. The maps of B. and M. and Lohrmann do not contain it, and I do not recollect to have ever seen it. However, 1832, Apr. 9, I made out distinctly, with only 3 inches of a Barlow achromatic, the double crater *Plato* K, and suspected a similar companion to a little crater near at hand, half way between it and the wall of *Plato* (designated *Plato* i by B. and M). This suspicion was converted into a certainty with a $3\frac{7}{10}$ inch aperture, 1836, May 25, when I was struck with the curious aspect of the two adjacent pairs, and made a note that "this object surely could not have escaped Schr.'s observations had it existed in his time." We learn something

* At another time he saw this as a hill, and curiously enough it is so represented in the maps of Lohrmann and B. and M. The "Sections" of the former do not extend to this region.

from experience. I think I should hesitate in making any such assertion *now*.

On the last morning Schr. found two other luminous specks, where he had never perceived anything whatever on former occasions: one, W. of *Menelaus*, and very similar in aspect to *Manilius*, falling on the site of the *Promontorium Acherusia* (Int. Obs., viii. 30) and *Taquet*, (a small bright adjoining crater); the other on the opposite side of the *M. Tranquillitatis*, at the *Mons Herculis* [qu: Prom. *Heracleum*] of Hevel [*Censorinus*, 90]: and here, he believed, as in former cases, was evidence of incidental modification, as though something occasionally interfered with the uniformity of reflective power on the dark side of the moon. Certain localities, it might be supposed, were liable to atmospheric obscuration, which could, he thought, be often traced, in the non-visibility of minute objects towards the lunar sunset, and which might be continued, or might be more likely to occur, during the lengthened night. And he mentions the curious fact, that during a very favourable view, 1790, Jan. 17, he not only noticed (what has already been mentioned) that the relative brightness of *Manilius* and *Menelaus* was interchanged, but that the considerable luminosity just mentioned on the site of *Taquet* could not be perceived again, excepting as a very minute point as bright as *Manilius* or *Menelaus* during the first 15m., of which afterwards nothing could be seen; that on the other side of the *M. Tranquillitatis* [at *Censorinus*] nothing more than a very slight increase of brightness could be at times perceived; and that in another direction [that of *Dionysius*, 25] he caught, but twice only, a very minute point, brighter than either *Manilius* or *Menelaus*, which he could not recover again. In all this he found, of course, the confirmation of his hypothesis. Shall we accept it as such, or shall we ascribe it to mere eye-weariness, and anxiety, and prepossession?—misrepresentation, no one that knows his writings would for a single instant impute to that honest man. We would answer, that we leave it to time to discover the value or the error of his observations and inferences. Some years ago we might have been disposed, like B. and M. to pass them by in silence; the new course of selenological investigation seems to demand a fuller treatment of a subject more difficult than it might at first appear.*

The observations of 12 subsequent years never renewed again to Schr. the illumination on the E. side of *Mont Blanc*; but the use of larger apertures—his 13 ft. reflector had about $9\frac{1}{2}$ inches, and his 27ft., $19\frac{1}{6}$ inches English measure—fully confirmed his previously formed opinions, and he has recorded the following interesting and final addition in his second volume.

* See especially Int. Obs. vii. 54, 55; viii. 295.

1794. Apr. 2, while the 13 ft. telescope was showing him, as might be expected, a large increase of faint specks in the earth-shine which could not be reached by his smaller instruments, he perceived in the region of *Agrippa* (26) and *Godin* (27) an extremely fine point of very bright light, intense enough to distinguish itself from all the rest, and to resemble a minute glimmering star; and which struck him so much the more, since it was entirely new to him. Its aspect was not that of earth-light, and its incidental nature was proved by the fact that a full quarter or half an hour later, when he wished to observe it again, though circumstances were equally favourable, he could find it no more with any certainty. With straining vision he imagined that he perceived a similar one further W., but it was not clearly distinguishable. Such a phenomenon he was then disposed to think might be readily referred to some artificial cause, since terrestrial fires of considerable size would no doubt be visible from the moon; it would seem, however, more consistent with our other knowledge to refer it to a volcanic origin.*

It will excite no surprise in the minds of those who have attended to the subject, that these observations were ignored by B. and M., viewed, at least, as the mere effect of more favourable circumstances and curtailed periods of observing. But the day has gone by, we hope, for such a superficial treatment of the subject; and the question has recently been revived in a very interesting form.

1865. Jan. 1. Mr. C. Grover, of Chesham, an observer whose name has already been made known to our readers, was looking at the moon at 6h. p.m., the sky being very clear, with an excellent 2-inch achromatic, when he perceived a little speck of light, which was very distinctly seen like a 4 mag. star very slightly out of focus, with a little light haze around it. Powers of 50, 65, and 80 were used, but the first was preferable. It was in view for fully half an hour, without change, and showing a perfectly steady light. He most carefully studied its position, and, the outlines of *Plato* and the *M. Imbrium* being discernible, found that it was close under the E. foot of the *Alps*, very near the mouth of the wedge-shaped valley: and consequently either exactly on the site of Schr.'s phenomenon, or so near to it that the coincidence is at any rate most remarkable. The epoch of Schr.'s observation was 3d. 12h., before new moon; that of Grover's 3d. 21h. after, and the site of the luminosity lying near the first lunar meridian, it is obvious that, allowance being made for probable dissimilarity of libration, the distance of the spot from the terminator on the

* A naked-eye observation of a bright spot, recorded in Phil. Trans. 1794, was evidently an occultation of Aldebaran, disguised by irradiation.

two occasions, though in opposite directions, would not be materially different. Taking into account the disparity of optical means, it must have been very much more luminous in the latter observation. The site deserves an especially careful scrutiny under varied solar illumination.

But this, though the whole of the evidence as to this particular district, is not all that has recently come before us.

1865. Nov. 24, about 6½h. p.m, the Rev. W. O. Williams, of Pwllheli, N. Wales, perceived, with a $4\frac{1}{16}$ in. object-glass, "a very pretty speck of light * * very much like a star of the 8th mag., but quite distinct and clear," which he observed for about 1¼h. with different eye-pieces, and saw better with 60 and 80 than with higher powers, though it was well seen even with 200. He showed it also to a friend, and one of his daughters found it quite independent of his directions. From careful allineation he believed its site to be at or very near *Carlini* (128), a small crater in the *M. Imbrium*, a neighbourhood which likewise ought to be studied in detail. As the moon was on this occasion 6¼ days old, the brightness of the spot must have been very considerable to have made itself so readily distinguishable.

A review of the whole of these statements seems to establish the fact that outbursts of native light are visible from time to time on the night side of our satellite. At present, it can hardly be said that the attempt to identify their sites with foci of volcanic action has been unsuccessful, because an attempt has never hitherto been made in a manner likely to ensure success. Schröter's investigation was carried on upon unknown ground: his larger crater was probably not a crater at all; the novelty of his small ones rests on evidence which would prove too much; and till of late the inquiry has been in abeyance. It should not remain so longer.

THE LUNAR CRATER LINNÉ.

Since the truly remarkable announcement in our last number by Schmidt, of the change in the crater *Linné*, neither the state of the air, nor the position of the terminator have been as favourable as might be wished for the careful examination of this object. However, the following observations may be thought sufficiently interesting for publication, till such time as many of our readers, we hope, will be able to do better by it themselves.

1866. Dec. 13, 8h. Silvered reflector, 9¼ inches, by With, power 240. Sky clear, but moon very low, and definition tremulous. Terminator about 1¼ diam., E. of *Aristoteles*; 2 diams., E. of *Eudoxus*, and through E. edge of *M. Serenitatis*. "About ⅓ of the way from a marked high mountain on N.

shore of *M. Seren.* to *Sulpicius Gallus** is a minute darkish looking crater; it is not well seen under these circumstances, but there can be no doubt as to its nature. This I presume is *Linné*, as I can trace no crater anywhere else. At some little distance S.E. there is an ill-defined whitishness on the floor of the *Mare*." Such was my record at the time; but on subsequently examining the map of B. and M. I was much struck by finding that my crater was unmistakeably *Linné* B, and that the site of *Linné* was *occupied by the whitish cloud.*

1866. Dec. 14. 6h. Same telescope and power: bad definition. Terminator through centre of *Archimedes*. The whitish spot in the place of *Linné* is barely as large as *Sulp. Gallus*; it is the most conspicuous object in E. half of *M. Seren.* *Linné* B not visible.

1866. Dec. 25. 19½h. Same telescope, power 170. Fine definition, too much *rippled over* for distinctness. *Linné* a very conspicuous white nebulous patch, containing some very indistinct and almost doubtful marking within it; I forget whether dark or light, but believe the latter: not such, however, as to suggest the idea of a crater under present definition. It is about equal to, but not quite so bright as, the larger of two white spots just N.E. of *Sulp. Gallus.* *Linné* A, B, d, and an unnamed hollow ⅓ of the distance from *Linné* B to *Calippus* K, were all very distinct as craters. (This, it will be observed, was in waning illumination.)

1867. Jan. 12. 5h. 35m. Same telescope, powers 212, 240. Unsteady and inferior definition. Ring of *Cassini* half in light, so that shadow of a peak in it fell on ring of *Cassini* A. *Theætetus* half touched by sun. On the site of *Linné*, nothing but a small ill-defined whitish cloud, not quite so large as *Sulp. Gallus.* There appears to be some slight marking as from a small shadow towards its centre, but far too indistinct to say whether caused by hill or hollow. Three small craters with dark interior shadow are quite distinct in moments of better definition. I believe they were *Linné* A, B, and the unnamed one already mentioned, but I did not examine the map till clouds had come on. The white cloud was by no means bright or conspicuous, though perfectly distinct.

The speculum used in these observations, though its figure has not received its final touch, gives very sharp and clear definition, and separates γ^2 Andromedæ with great ease. The value of the powers is at present only approximate.

It will be, of course, most desirable to watch for the moment when *Linné* has just entered into sunshine, and its relief comes out in light and shade. It would be troublesome

*A small bright crater in the *Mare*, close to the S. shore, some distance E. of *Menelaus*.

to compute this epoch accurately, but it may assist our preparation to observe, that two evenings previous to such a presentation, the E. side of the great crater *Hercules* (5) will be upon the terminator, which will pass through *Plinius* (13) the next day.

In addition to the valuable information contained in our last number, our readers may be glad to have the precise wording of the original observations laid before them, as far as they lie within my reach. Schröter, 1788, Nov. 5, describes the course of his 6th ridge in the *Mare*, from a small crater on the S. shore (b *Sulp. Gall.* B. and M.) northward to another somewhat uncertain one v, "about equally large, but quite flat, appearing like a white, very small, round speck," and thence to g, "a not sharply-defined dark spot, which during that observation had only some ½° light, and consequently struck the eye as considerably darker than the rest of the plain, and was somewhat indistinct, from lying very close to the terminator." The choice of the site of *Linné* lies between these two; from a comparison of Schr.'s drawing with B. and M., I incline to v; and should this be correct, its appearance then was not very unlike its present, excepting that he makes no mention of the whitish cloud.—In Lohrmann's Section IV. (1824) and his map (1822 to 1836) it is a distinct crater. In his text it is stated that he measured its position, and that it has "a diameter that amounts to somewhat more than one (German) mile, is very deep, and can be seen in every illumination."—B. and M. call it "the deep crater *Linné*;" they measured its position seven times, gave it 1·4 mile in breadth and 6° of brightness, and remark that it is ill-defined in full moon; but without any mention of the white cloud which is now so conspicuous in high illumination.*

OCCULTATIONS.

Feb. 9th, μ Piscium, 5 mag., 7h. 38m. to 8h. 35m.—12th, θ^1 Tauri, 4½ mag., 12h. 50m. to 13h. 38m., its companion θ^2, 4½ mag., 13h. 0m. to 13h. 32m. B. A. C. 1391, 5 mag., 13h. 37m. to 14h. 26m. (worth sitting or getting up for).—13th, 111 Tauri, 6 mag., 11h. 2m. to 12h. 6m. 117 Tauri, 6 mag., 12h. 45m. to 13h. 35m.—16th, 29 Cancri, 6 mag., 12h. 13m. to 13h. 19m.

* [Having several times looked at *Linné* with a very fine 6½-inch reflector by Browning (with With's mirror), we should have preferred calling its present appearance a *whitish spot*. It does not, to our eyes, sufficiently differ from other whitish spots to be distinguished from them as a "cloud."—Ed.]

THE FOSSIL FOREST OF ATANAKERDLUK.

THE *Archives des Sciences* (No. 107) contains a report of a paper by Oswald Heer, on the fossil forest of Atanakerdluk, in North Greenland, from which the following particulars are taken.

The forest in question is situated in lat. 70° N., and numerous specimens obtained from it were brought to England, and from thence sent for examination to M. Heer. All the indications show that the trees grew in the place in which they have been found, and many of the leaves are so well preserved as to exhibit fragments of insects on their surface.

The forest of Atanakerdluk probably dates from the commencement of the miocene period, for out of sixty-six species of plants recognized in it, eighteen belong to the miocene formation of Central Europe, nine of which were widely diffused, and are met with in the two divisions of the *molasse*. These last are as follows: *Sequoia Langsdorffi, Taxodium dubium, Phragmitis Œningensis, Quercus Drymeia, Planera Ungeri, Diospyros brachysepala, Andromeda protogœa, Rhamnus Eridani,* and *Juglans acuminata.* Some species, on the contrary, have not been found in the upper *molasse*, such as *Sequoia Couttsiæ, Osmunda Heerii, Coryllus Mac Quarrii, Populus Zaddachi.*

The discovery of this fossil flora shows that the north of Greenland formerly enjoyed a much higher temperature than at present. When M. Heer arrived, from a study of the Swiss miocene flora, at the conclusion that the climate of that country must formerly have been almost tropical, his opinions were assailed, and it was contended that the plants in question might have been able to withstand a lower temperature than their living representatives. This objection, of slight value in face of the evidence adduced by M. Heer, is completely disposed of by the discovery of the ancient flora of Greenland.

A great forest in the 70th parallel of latitude vividly strikes the imagination, when we reflect that all arborescent vegetation has disappeared from those regions; and we are still more astonished when we ascertain the sort of trees that formerly shaded their soil. It is from 10° to 20° more south that we must now seek their living representatives, such as the *Sequoia* now found in California, which compares with the two fossil species of the Greenland forest. A *Salisburea* which once lived there is now represented by a single species, which grows in Japan. Four species of oaks grew in this forest; the *Quercus Drymeia,* which had an evergreen foliage; the *Q. Green-*

landica, with leaves six inches long; another large-leaved oak, *Q. Olafseni*; and the *Q. atava*, which resembles our common oak. Here also abounded plane trees, magnolias (*M. Inglefieldi*), walnuts (*Juglans acuminata*), an evergreen plum (*Prunus Scottii*), a Planera,* etc. In the midst of these trees grew many shrubs, a hazel nut, an ivy, three briars, and an *Andromeda*,† while ferns carpeted the ground.

All these genera are now represented by species much allied to the old Greenland flora; but there are some which exhibit divergent forms, and whose relation with existing species is more or less doubtful—these are a *Zamites*, a *MacClintockia*, and the *Daphnogene Kanii*. This last is a green plant, with a thick leathery leaf, supported by a petiole nearly a foot long. The *MacClintockia*, with its leathery leaves, more or less lanceolate, entire, or denticulated, having from three to seven veins (*nervures*), forms an entirely isolated genus, of which the three species described appear to belong to the family of the *Proteaceæ*. The *Zamites arcticus* had its leaves divided into small thin straps, and did not exceed the dimensions of a shrub. As these plants have no living analogues, we cannot tell the temperature necessary for their development, but green plants with thick leathery leaves appear always to belong to a tolerably southern climate.

If we find that the *Sequoia Salisburea*, and the *Quercus Drymeia*, and *Olafseni* grew in the 70th parallel of latitude, it is natural to suppose that planes, beeches, pines, and nut-trees extended still further north, and perhaps reached the Pole. This inference is supported by the fact that in latitude 78° the miocene flora includes the plane, the hazel, the beech, the pine, and the Taxodium of Atanakerdluk. The masses of petrified wood found by MacClure and his companions in latitude 74° need no longer astonish us. They afford another proof that forests formerly covered vast spaces which are plains of ice.

So many circumstances influence the development of plants, that it is difficult to fix the temperature of the Greenland climate at this forest epoch. The *Sequoia Langsdorffi* formed a great part of the Atanakerdluk forest, whole branches have been recovered, and each fragment of rock bears its imprint. It played an important part in the miocene flora; it is found in the banks of the Mackenzie, in the Rocky Mountains, and, in Europe, Italy has furnished specimens. The *S. sempervirens*, which may be regarded as its descendant, forms in California great forests, which extend from Mexico to

* "Planera trees, natives of Asia and N. America, belonging to the *Ulmaceæ*, and closely allied to the elms."—See *Treasury of Botany*.

† A genus of Ericaceæ.

the 42°. It requires 15° to 16° (about 60° to 61° F.) of summer heat to live, and 18° to mature its fruits. The lowest temperature it can withstand is —1° (30·2° F.), and the mean annual temperature must be about + 9·5°. Such at least must have been the Greenland climate at its lowest limit, for the Daphnogene, the MacClintockia, and the Zamites, probably required a higher temperature. The present mean of this country being —6·3° (20·75° F.), it must during the miocene epoch have been 16 centigrade degrees warmer.

PROGRESS OF INVENTION.

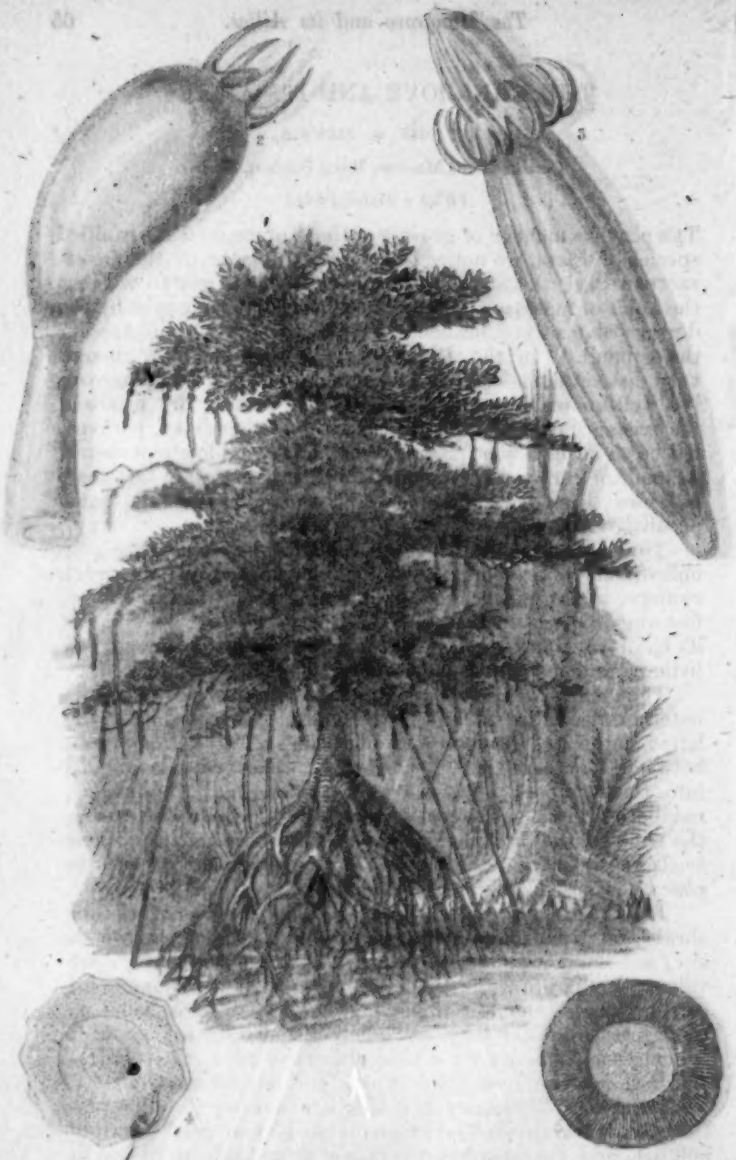
FORMATION OF CRYSTALS.—There can be no doubt that time is often an essential element in the formation of crystals; this is particularly true of the diamond and other precious stones, and no doubt constitutes the obstacle to their artificial production. Hitherto, the chemist has been unable to crystallize certain compounds thrown down from their solutions; a simple means of effecting this has, however, been devised by M. Frenny. He considered that the amorphous form of precipitates arises from the rapidity with which the precipitation takes place, and therefore expected to obtain crystals by diminishing that rapidity. The result was such as he anticipated. In this way he procured crystals of the sulphates of baryta, strontia, and lead, of the carbonates of baryta and lead, etc. He obtained even crystals of quartz, which were sufficiently hard to scratch glass; but they were not pure, containing five per cent. soda and twenty-seven per cent. water.

SIMPLE FORMS OF GALVANIC BATTERY.—Hitherto the metallic solution produced in the galvanic battery, when saturated, was no longer capable of use for the purpose. It has been found, however, by M. Montiers, that such need not be the case, if we avail ourselves, in succession, of two metals having very different electro-chemical properties. As an illustration of this principle, he first places a cylinder of malleable or cast-iron in a vessel, and inside of the iron a prism of carbon; then pours in dilute sulphuric acid. The iron and graphite act as electrodes, and the electricity developed by a single couple of this kind is sufficient to keep a bell-ringing apparatus in action for a considerable time. When this battery is exhausted, he concentrates the solution of sulphate of protoxide of iron formed by it, and immerses in it electrodes, which in this case consist of zinc and carbon. The zinc is dissolved, hydrogen is liberated, and hydrated protoxide of iron is set free. The energy of this latter battery is sufficient to keep the bell-ringing apparatus in action for several months. M. Montiers also avails himself of the fact that oxide of zinc acts as a base with acids, but as an acid with ammonia and other strong bases, for the production of a very economical battery. For this purpose, he avails himself

of the carbonate of ammonia in urine, which has spontaneously decomposed, immersing the zinc in that fluid instead of in the sulphate of the peroxide of iron. According to his experiments, as detailed to the Academy of Sciences, the resulting battery is not only cheap, but effective. It is probable that zincate of ammonia and carbonate of zinc are formed during the action which takes place.

PHOTOGRAPHY UNDER WATER.—No place is now safe from the incursion of photographers. Who would suppose that they could carry on their operations under water? Yet such is now the case, as M. Bazin has proved. His photographic studio consists of a strong sheet-iron chest, perfectly water-tight, with water-tight windows, that are in the form of lenses. The electric light is used, and renders distinctly visible any objects lying at the bottom of the sea, so that they may be photographed, and thus their nature and position be accurately marked. M. Bazin has remained at depths of nearly three hundred feet for about ten minutes. This application of photography promises to facilitate the recovery of lost objects, and the raising of sunken ships, etc.

A NEW PETROLEUM LAMP.—A lamp has just been contrived by M. Leplay, of Paris, that promises to be a very interesting addition to man's appliances for purposes of domestic illumination. The lamp consists essentially of a hollow ball of brass, mounted upon a stem and stand. The ball is closed at the top by a closely-fitting plug. When this plug is removed, the opening is seen to lead into an interior cylinder, or space separated from the rest of the interior cavity by a roll of metallic gauze. Between the gauze cylinder, and the external wall, the lamp interior is packed with sponge. When the lamp is to be charged, a quantity of a light and cheap form of Benzule, distilled for the purpose, is poured into the space, and the superabundance, over and above what is sufficient to saturate the sponge, is poured back again from the lamp, and the plug is closed. The lamp is then ready for use. The interior space of the lamp is immediately filled with the elastic vapour of the Benzule, which pours out as a stream of inflammable gas when the plug is removed. When this stream is lit it continues to burn with a bright clear flame, until the sponge is exhausted by the process of spontaneous evaporation. About two-thirds of an ounce suffices to charge the sponge, and this charge enables the lamp to burn for about eight hours. This is the extraordinary part of the affair. The light of the flame is equal to something like that of two composite candles. The lamp may be turned over, and rolled about the floor upon its side, without in any way interfering with its burning, otherwise than by causing the flame to keep itself turned up at right angles to the vertical axis of the lamp. There is, of course, nothing to spill. If the lamp is turned upside down and jogged, while burning, it becomes apparent that the Benzule gas is heavy. The flame then drops from the lamp in successive sparkles. A considerable number of the lamps are to be immediately sent over to England for public sale.



MANGROVES.

Rhizophoraceæ.

THE MANGROVE AND ITS ALLIES.

BY JOHN R. JACKSON,

Curator of the Museum, Royal Gardens, Kew.

(*With a Tinted Plate.*)

THE peculiar manner of growth of the Banyan, and other allied species of *Ficus*, we noticed in a recent number of the INTELLECTUAL OBSERVER. In the *Moraceæ*, it will be recollected that the habit of increasing the circumference of the plants, is by the downward growing branches, which strike root upon meeting the ground. In the *Rhizophora*, another singular, though very distinct mode of growth occurs, and of this the Mangrove is a well-known example. Most of our readers are aware of the existence of such a plant; but some of them may, perhaps, not be so intimately acquainted with it as to understand clearly its mode of germination; nor are they, perhaps, aware that there is more than one species of *Rhizophora*, having the same peculiarity.

The name of Mangrove is associated in our minds with very unfavourable ideas of locality, we have read of Mangrove swamps, and we have notions of stagnant or muddy shores, fostering malaria or disease. We most of us know so much of its habitat; but we will endeavour to explain to our readers a little more about the Mangrove and its allies.

The genus *Rhizophora*, then, gives the title to a distinct natural order called *Rhizophoraceæ*, and placed according to the latest authority, Hooker and Bentham's *Genera Plantarum*, between *Haloragеæ* and *Combretaceæ*. The order is divided into three tribes: *Rhizophoræ*, *Legnotidæ*, and *Anisophyllæ*, numbering in all seventeen genera, and the four comprising the tribe *Rhizophoræ*, have a similar habit of germinating their seeds before leaving the parent, these four genera are *Rhizophora*, *Ceriops*, *Kandelia*, and *Brugueira*.

The order is entirely a tropical one, and consists of trees or shrubs, mostly inhabiting the sea shore. The leaves are opposite, and the flowers usually axillary, the lobes of the calyx are valvate, not imbricate, the stamens arise from the same point as the petals, and are twice or three times their number, though in *Kandelia* they are indefinite. The ovary or fruit is sometimes superior, or seated above the calyx, as in *Rhizophora*, the calyx is persistent in several of the species.

The genus *Rhizophora* is distinguished from its allies, by the calyx being divided into four parts, the four petals sharply pointed, and the stamens which are from eight to twelve in number, having short filaments, and anthers with little pits,

containing the pollen. The ovary is partially adherent, and contains two cavities in the part where it so adheres, each of these cavities bearing two ovules; the free part tapers towards the top into a single style.

The Mangrove, *Rhizophora Mangle*, L., is an evergreen tree, rising some forty or fifty feet high, and presenting a very singular appearance, both as regards the appendages of its branches, and its peculiar manner of rooting. The following description of the Mangrove, is from a paper, read before the Pharmaceutical Society, by Dr. Hamilton, in June, 1846.—"The Mangrove is a tree frequently of imposing stature, attaining an altitude of from thirty to fifty feet or more, and occupying marshy situations, in the vicinity of the sea, as at the bottom of English Harbour, Antigua, and near the mouth of the little river which empties itself into the harbour, at Cape Henri, Hayti. Its roots rise in the form of arches, above the muddy soil in which it grows, and affords attachment to myriads of small but delicious oysters, which are left bare during the efflux of the tide, giving rise to the popular fable of oysters growing on trees, which, with the exception of their not being fed by, but merely adhering to the tree, is literally true. These oysters make a most incomparable soup, of which I once partook at the house of an American merchant, at Cape Henri.

"The shade of these trees affords harbour during the day to innumerable swarms of mosquitoes, which nestle on the under surface of the leaves, and infest the houses of those who have the misfortune to live in the vicinity of a Mangrove swamp during the night.

"But in the economy of nature, the Mangrove performs a most important part, wresting annually fresh portions of the land from the dominion of the ocean, and adding them to the domain of man; this is effected in a two-fold manner, by the progressive advance of the roots, and by the aerial germination of the seeds, which do not quit their lofty cradle, till they have assumed the form of actual trees, and drop into the water with their roots ready prepared to take possession of the mud in advance of their parent stems, and repel to a further and perpetually increasing distance the invasion of the water. The progression by means of the roots is effected by fresh roots, which issue from the trunks, at some distance above the surface of the water, and arching downwards, penetrate the mud, establishing themselves as the pioneers of fresh invasions of the retiring element. In this manner the plants soon after their descent from their parent trees, continue, during their early years, to advance steadily forward till they have attained a height of about fifteen feet, and considerably in advance of

their parent trunks. After this, fewer additions are made to the roots, but the head begins to expand in every direction, spreading its branches on all sides; these branches in their turn, send down long slender roots, like those of the Banyan fig tree (*Ficus Indica*), which, rapidly elongating, descend from all varieties of height, and reaching the water, penetrate the mud, becoming in time independent trees; thus a complicated labyrinth of vegetation is at length formed, serving to arrest the particles of soil washed down from the interior; these, by their accumulations, raise the level of the ground, till at length what had been water, is converted into a salt marsh; and what had been a salt marsh, becomes progressively dry land, fit for the cultivation of man, and teeming with fertility from its copious intermixture with the exuviæ of marine animals and vegetables." The author of this description, compares the germination of the Mangrove to that of the Banyan, in "sending down long slender roots;" but it must be borne in mind, that these roots in the *Rhizophora*, are not spongioles, borne at the ends of the branches, but are the true radicles, and the only difference to the general law of vegetable life, is that they germinate before leaving their parents, so that the long stick-like protuberance from the fruit, is the young root, which reaches downwards towards the ground as far as possible, and when no longer able to hold on to the parent, drops into the mud below, and then sends out its rootlets; the rudiments of which are clearly distinguishable on the surface of the radicles, as they hang from the trees.

Dampier, in his voyages, says: "The Red Mangrove groweth commonly by the sea-side, or by rivers and creeks. It always grows out of many roots about the bigness of a man's leg, some bigger, some less, which, at about six, eight, or ten feet above the ground, join into one trunk or body that seems to be supported by so many artificial stakes. Where this sort of tree grows it is impossible to march by reason of these stakes, which grow so mixed one among another that I have, when forced to go through them, gone half a mile and never set my foot on the ground, stepping from root to root. The timber is hard, and good for many uses; the inside of the bark is red, and it is used for tanning of leather very much all over the West Indies."

In places where Mangroves abound, the propagation is effected by the simple and natural process of the germinating seeds dropping into the mud and immediately throwing out their rootlets. The fruit, before germination takes place, is described as being edible and of a sweet flavour, the juice of which is fermented and made into a kind of wine. The economic uses of the Mangrove are very many. A kind of

rough salt is extracted in Borneo from the aerial roots, and the wood is considered the best firewood of any produced in the island. The bark is well known as a tanning bark, for which purpose it is much valued; indeed, it has been said to equal, if not to excel, oak bark in the quantity of tannin which it contains. It is also used for dyeing, producing, in conjunction with mineral salts, olive, brown, and slate colours.

It is not the bark alone that contains tannin, but all parts of the plant. The leaves and roots of some of the species are used in the Mauritius and the West Indies for poultices; and in the last-named islands, as well as in the Phillipines, the bark is considered a good febrifuge. There are four or five species of *Rhizphora* known.

Ceriops stands next to *Rhizophora* in scientific classification. Two or three species are described, natives of Eastern Africa, Asia, Australia, and Polynesia. One of the distinctive characters of this genus is the five parted persistent calyx; the petals, also in fives, are pubescent or hairy at their points; and the ten stamens are seated two together in front of the petals. The bottom part of the ovary has three cells, each cell containing two ovules, the upper part of the ovary terminating in a long style, and the seed germinates before leaving the tree in a similar manner to that of *Rhizophora*.

Kandelia is a genus of which but one species is known, namely, *Kandelia Rheedii*, W. et A. It is a native of the East Indian Islands. The parts of the flowers of this, like the last-named genus, are in fives, but it is distinguished chiefly by the petals being divided and sub-divided into numerous fine divisions, and seated in a fleshy rim or disk, which lines the calyx tube. The stamens are indefinite, the filaments very fine, and the anthers small and oblong. The flowers are white and green; the fruit is ovoid, coriaceous, one-celled, and one-seeded, germinating on the trees as in *Rhizophora*. The bark of this tree, mixed with ginger or long pepper, and rose-water, is a reputed medicine among the native practitioners in India for the cure of diabetes.

Brugueira is a genus having six or eight species, natives of Eastern Africa, Australia, and the Polynesian Islands. They are trees frequenting the shores of rivers and muddy swamps, and are known from the preceding genera by the numerous lobes or limbs of the calyx, varying from eight to about fourteen, which adhere to the ovary below, thus making the calyx superior, or seated above the fruit, and standing up in a whorl round the radicle. From this arrangement of the sepals, the radicle might easily be mistaken for an elongated fruit. The petals agree in number with the sepals; they are coriaceous, and woolly at the edges, and cleft or divided in two parts.

The number of stamens are from sixteen to twenty-eight, and are placed as in *Kandelia*, in pairs, opposite the petals, and each petal is folded so as to form a hiding-place for the filament. The ovary has from two to four cells, each cell containing two ovules. The fruit being inferior, and the calyx persistent, it remains at the apex of the fruit; and when germination takes place, it is simply pushed away from the centre to make room for the young radicle. In this genus the roots are thrown up from below all round the root, as shown in plate.

The internal structure of the main root of the mangrove (*Rhizophora Mangle*, L.), as shown in a cross section, differs from that of the radicle. A good idea of the former may be had from Fig. 4, the outer and the central parts of which are masses of reddish brown fibrous tissue, while the ring is a very white, hard, woody substance, with clear and distinct rays crossing it in a direct line. A section of the radicle shows in the centre a mass of loose fibre surrounded by woody tissue, made up of silky fibrous bundles, the whole of a similar colour to the true root. The outer covering is composed of fine bundles of close, hard, woody fibre, arranged more or less regularly parallel.

The root of *Brugueira* shows in a cross section (Fig. 5) a similar arrangement to that of *Rhizophora*, except that the portion between the outer epidermis, or cuticle, and the ring of wood, is composed of thin paper-like divisions, regularly arranged, instead of an indiscriminate mass of fibrous tissue. These divisions, as will be seen by the figure, are very evenly placed, radiating from the centre. The appearance of one of these papery walls under the microscope is very singular and beautiful, presenting a mass of fine, glittering, scale-like markings.

DESCRIPTION OF THE PLATE.

Fig. 1.—Mangrove tree, *Rhizophora Mangle*, L. To the right is seen a tree of *Brugueira sp.*, showing its singular manner of throwing up its roots.

Fig. 2.—Germinating fruit and portion of the radicle of *Rhizophora Mangle*, L., showing the inferior calyx.

Fig. 3.—Germinating fruit and radicle of *Brugueira sp.*, showing the superior calyx. This is here represented as being reflexed, having been drawn from a dried specimen. It stands erect when fresh.

Fig. 4.—Cross section of root of mangrove, *Rhizophora Mangle.*

Fig. 5.—Cross section of root of *Brugueira sp.*

THE MAMMOTH AND ITS EPOCH.*

THE discovery of the bodies of enormous animals akin to the elephant in the frozen soil of Siberia has excited the astonishment of naturalists and of the vulgar. The primitive nomads regarded them as monstrous burrowing rats, whose life was extinguished as soon as they saw the light of day; and the Chinese supposed that their subterranean movements gave rise to earthquakes. It has been generally supposed that Siberia had, in the mammoth days, a much warmer climate; M. de Middendorff disputes the conclusion, and states that the wood found in N. Siberia, and supposed to have grown there, is in reality drift-wood. It is also remarked, that the hypothesis of former heat in the Siberian climate would not solve the enigma, as it would not explain the good preservation in which the bodies of the great animals has been kept, which would seem only possible in a frozen soil, and the climate could not have changed so suddenly as to leave no time for their decomposition. Besides, the mammoths were well furnished with hair, and were not intended, like the modern elephants, to inhabit hot countries. Fir needles have been found between the teeth of rhinoceri, buried by the side of the mammoth, indicating that the latter may have lived in forests of conifers; but what was its food in the steppes which are beyond the limits of arborescent vegetation? M. de Middendorff supports the opinion that the bodies of the mammoths were drifted from more southern regions; but if this were the case, how is it that their bodies came to be so perfectly preserved in ice, and how was the congelation effected? Is it possible, as Adams thinks, that they found their sepulture in the midst of pure compact ice, and have been preserved there for millions of years?

On the recommendation of M. de Middendorff, the St. Petersburg Academy offered rewards of 100 to 150 roubles for the discovery of a complete mammoth skeleton, and of 300 roubles for that of a body with the soft parts entire. At Christmas, 1865, M. K. C. Von Baer received from Barnaul a notification that a Samoyede-Jurack had found an entire mammoth in 1864, with its skin, near the Bay of Tas, which opens into the Gulf of Obi.

This discovery, which was mentioned in former numbers of the INTELLECTUAL OBSERVER, induced the Academy of St. Petersburg to send M. Frederic Schmidt to the spot. On the 24th March (last) he arrived at Yenissek, and from thence forwarded a piece of the mammoth's skin, which had been

* Abridged from an article in the *Archives des Sciences*, No. 108.

brought there by its discoverer. From Yenissek he was to travel, in the winter, to Ochotskoje (70½ N. L.), and to await for the disappearance of the snow for an opportunity of seeking for the mammoth. Pending his researches, MM. K. C. Von Baer and J. F. Brandt have published memoirs on the mammoth, from which the following information is taken :—

In the seventeenth century, Burgomaster Wilson, of Amsterdam, took great pains to collect information from Siberia, and he pointed out many localities in which mammoth tusks had been found, and added that certain animals had been seen, which were brown-coloured, and diffused a great stench.

In 1692, Ysbrandt Ides, sent overland as ambassador from Pekin to Peter the Great, reported that a man who collected mammoth ivory every year had found a mammoth's head sticking out of the ground, and had cut it off, and sent it to Turuchansk, together with a foot which he had also seen.

Messerschmidt found a skeleton which he thought complete, on the banks of the Tom.

In 1739—43, Chariton Laptew, who traversed the western coast of Siberia, reported that whole mammoths, with thick fur, were dug out of the banks of the Tundra.

In 1771, a rhinoceros, in a state of decomposition, was found on the banks of the Wiljui, and Pallas subsequently sent its head and foot (which had been brought to Irkutsk) to St. Petersburg.

In 1787, Lieut. Sarytschew heard at Alaseisk, on the river Alaseja, that the carcase of an animal as big as an elephant, covered with skin and with patches of long hair, had been found about 100 versts from that place, and about the same time a mammoth with skin and hair was found at the mouth of the Lena. Another mammoth with fur was seen on the shores of the Polar Sea; but the most celebrated discovery was that of Adams, the botanist, in 1806. This mammoth was near the mouth of the Lena. It had slipped down from a bank of sand, and was much torn by dogs and wild beasts.

The naturalist, M. Schrenk, in his journey through the country of the Samojedes, collected information concerning two skeletons found in the great peninsula between the Carienne Sea and the Gulf of Obi.

The Moscow skeleton, deficient in its posterior extremities, belonged to an animal discovered at Jenissei in 1839.

In 1843, M. de Middendorff found the remains of a mammoth in lat. 75°, near the Taimyr, fifty versts from the Polar Sea. The soft parts were decomposed, and the bones had lost their hardness.

Twenty years ago another mammoth was found in the

district of Yakustk, and to this the foot brought to Irkutsk, and seen by Leop. Schunk, is supposed to have belonged.

In 1860-62, M. Golubew reported the discovery of a great animal, with its skin, not far from the junction of the Wiljui with the Lena, and early in 1864 the mammoth already mentioned was seen.

M. K. E. von Baer remarks that the complete mammoth skeletons, with soft parts covering them, bear a small proportion to the quantity of mammoth remains found in a fragmentary state in northern Siberia. The flesh can only be preserved at a certain depth in a permanently frozen soil. The isolated bones and the complete skeletons represent much more than a single generation of the creature. Mammoth remains are scattered over Europe, though complete skeletons are rare, and Dr. Falconer found several species of fossil elephants in India. In Europe three species have been recognized, *Elephas primigenius*, *E. antiquus*, and *E. meridionalis*. Those of Italy appear to belong to the last species, as also do some of those found in the south of France. The northern regions of Siberia now furnish the most abundant remains; but as the southern parts have been long inhabited, it is possible that their inferiority in this respect has resulted from the quantities of tusks that have been removed by fossil ivory collectors, whose occupation is known to have been ancient. Certain isles of the Polar Sea now supply the greatest abundance, especially the Ljächow Isles, north of Swätoi-Noss, between the mouths of the Lena and the Indigirka, about 74° lat. The soil of the first of these islands is composed of fossil bones, which are loosened by storms and by the action of the sun. A group of large islands, not yet visited by a naturalist, and known as New Siberia, appear to contain an immense quantity of bones, accompanied by bitumenized tree trunks. Fossil ivory, weighing 20,000 lbs., was collected in the locality in 1821, notwithstanding a previous collection of 10,000 lbs, in 1809.

Extensive remains are also found at the mouth of the Chatanga, and the north-east angle of Siberia furnishes a large annual supply of tusks, contrary to what might be expected if the mammoths had drifted from the south. The two Anjui, affluents of the Kolyma, are also very rich in fossil bones, and it is the opinion of travellers and ivory hunters that the quantity of tusks increases as the districts are more north. M. de Middendorff estimates the quantity of fossil ivory annually obtained from N. Siberia at 40,000 lbs., and this is a low average, as he states 60,000 lbs. to have been the smallest quantity obtained between 1825 and 1831; and he mentions two years in which the quantity rose to 80,000 lbs. As in the extreme north the tusks are in general small, and do not exceed 120 lbs. in New

Siberia, we may assume that the quantity mentioned resulted from the spoils of at least 150 animals, or, making allowance for young ones and damaged specimens, 200 would be a probable supposition.

With respect to the date at which these creatures lived, M. de Middendorff observes that the Taimyr specimen was buried under a stratified mass of sand and clay thirty-five feet thick. He could not discover any trace of marine mollusks, but half way up the slope he found a layer of pulverized lignite, one inch thick, mixed with gravel, which indicated a prolonged action of a gentle water current, and was inconsistent with the supposition that the sandbank had been formed by a sudden catastrophe. The presence in the sand, below the mammoth remains, of large pebbles of different mineral characters, seemed to indicate that they had been brought from various localities by blocks of ice, which had deposited them in situations which larger blocks could not reach.

M. Von Baer states, that in the Tundra and on the banks of the Taimyr, he noticed that the mammoth remains were always in layers, above the beds composed of sand with pebbles, and he considered the mammoth layers as resulting from the erosive action of the sea on coasts recently emerged, and in process of elevation; and he found near the mammoths in some beds marine shells of species still living in the Polar Sea.

From these facts he concluded that the mammoth lived at an epoch when the climate was pretty much as it is now. Rejecting all ideas of sudden cataclysmal changes, he observed that, if at the eocene epoch the climate was tropical, and if during the formation of the upper miocene beds the majority of the tropical animals and vegetables still existed, and if at that time the mean temperature of the polar circle was many degrees higher than at present, the mammoths cannot be assigned to an earlier epoch than that of the transition between the pliocene and post-pliocene epochs.

M. Von Baer does not doubt that the mammoths were contemporaneous with man, and in addition to other evidence, some Chinese traditions point in this direction.

The most important question concerning mammoths is, whether or not they lived on the coasts of the Polar Sea, which are now destitute of forests, or whether their remains were carried from the north by rivers descending from the wooded country of Southern Siberia. M. de Middendorff adopts the latter hypothesis, and remarks that while it is not uncommon in Southern Siberia to find remains of animals which seem to have lived on the spot, and to have been engulphed in a standing position, the remains found in the

north are deposited on their sides. On the other hand, it is difficult to account for the transposition of the bodies of the mammoths, without injury, to great distances.

M. Brandt, adopting an intermediate view, says, "The numerous examples of mammoths found erect, combined with the idea that those which have preserved their skin and hair without injury could not have been carried along by water, induced me to communicate to M. Humboldt the opinion that the carcases in good preservation had been buried in an alluvial deposit (*vase*) in the locality in which they were found; that they had subsequently been covered by fresh layers of fluviatile deposit, and frozen in the autumn. A rigorous winter succeeding completed the process, and the frigid alluvium had preserved them against thaw from their time to ours." M. Brandt considers that the climate must have been warmer to have allowed the growth of sufficient vegetable food in Northern Siberia, but not temperate, or the mammoth carcases could not have remained frozen.

It is hoped that the researches of M. Schmidt will solve some of these doubts.

ARCHÆOLOGIA.

Mr. J. T. Blight, one of the most distinguished of the Cornish antiquaries of the present day, has recently communicated to the Penzance Natural History and Antiquarian Society the result of excavations in the Treveneage Cave, in the parish of St. Hilary, near Penzance. This cave consists of a series of subterranean chambers, which were first discovered, about twenty years ago, by the removal of some of the roofing stones in the course of agricultural labours. In the earlier part of last October, an attempt was made to resume these former explorations, and they were continued during the rest of the month with considerable success. They have, as far as now carried, brought to light a passage about forty-five feet long, four feet wide at the base, and three at the top, and four feet nine inches high. The whole is walled with dry masonry, the stones being carefully placed so as to receive the large slabs thrown across to form the roof, which is still perfect in the easternmost part to a length of twelve feet six inches. Within a foot of the extremity of this passage, a doorway, one foot six inches high by two feet four inches wide, the jambs and lintel of which are each formed of one stone, leads into a cell cut in the clay, with an arched roof, but without any coating of stones. It is of an elliptical form, fifteen feet long by six feet broad, and only four feet high. At right angles to this doorway, and at the end of the passage, is another door, about the same height, but only one foot three inches in breadth. This leads into a chamber which, when first opened, was found to be com-

pletely filled with clay and stones. This had been only imperfectly cleared out at the time when Mr. Blight made his report. At the beginning of the recent excavations, a part of some iron instrument, with a socket, was found about midway in the length of the great passage; and several other pieces of iron—some, it appears, with wood adhering to them, were found in different parts of the cave. Several pieces of worked bone were found, and two or three varieties of pottery, one of which had been an elegantly-shaped vessel of a very fine ware, glazed or enamelled within and without, and with a kind of zigzag ornamentation. This is pronounced by Mr. Blight to be undoubtedly Roman. At the bottom of the passage, for a length of twenty-six feet, the space now uncovered was found to contain a mass of burnt stones and other matter, with great quantities of charcoal, small pieces of bone, and fragments of pottery. This black layer was from eight inches to a foot in depth; and in the midst, adjoining the north wall, a carved bone, fifteen inches in length, and one and a half inches thick, was found, laying close behind a broader piece, six and a quarter inches long, which rested on pottery. There were within a radius of a few inches other pieces of pottery, but not enough to form a complete vessel, with charcoal, a lump of corroded iron, four inches long, and a portion of a large flint pebble. In this passage, also, was found a wrought stone, four inches square by three thick, resembling in form a modern building brick; and other stones, which seemed to have been used for sharpening tools, or for grinding, with a rude stone celt or hatchet. The floor of the elliptical chamber was also strewn with charcoal—some pieces so entire as to show the original size of the wood.

The mixture in this "cave" of objects apparently Roman with others of a ruder character, may perhaps indicate only that it was occupied in the Roman period by people who belonged to the older native population, of whatever race, and who were perhaps employed in the mining operations formerly carried on in this district. The presence of so much burnt materials may perhaps be partly explained by the circumstance, that the field in which the cave is found, which occupies high ground midway in the isthmus stretching from Hayle to Marazion, and commanding nearly the whole of the valley, with Tregoning, Castle-an-Dinas, and other hill-castles in view, is called the Beacon. Mr. Blight deserves great praise for the careful and intelligent manner in which he has carried on these excavations.

Much attention has been called of late to the SCULPTURED ROCKS, which are found especially in Northumberland and the eastern border of Scotland. We have before us a very valuable little book on these singular remains, by Mr. George Tate, of Alnwick, the author of a very excellent *History of Alnwick*, the first volume of which has been recently published. The book to which we allude is entitled *The Ancient British Sculptured Rocks of Northumberland and the Eastern Borders, with Notices of the Remains associated with these Sculptures.* Mr. Tate's very comprehensive essay contains carefully executed engravings of all the rock sculptures he has been able to trace through the district just mentioned. These sculp-

tures, as it is well known, consist chiefly of groups of concentric circles, with straight lines drawn from the centre to the exterior, and sometimes from the centre of one group to that of another group. Mr. Tate, whose essay we recommend to the attention of our readers, thinks that these sculptures date back as far as from 2500 to 3000 years ago, that they are the work of the primeval Celts, that they were made with stone implements, and that they have a symbolical meaning. Mr. Greenwell considers them to be undoubtedly religious. Mr. Tate quotes a writer in *Notes and Queries*, who says, that in a Welsh book, published in 1710, allusion is made to a custom formerly prevalent among shepherds in Wales, of cutting on the turf a labyrinthine form they called *Caer-Droida*—the walls of Troy—a practice supposed to commemorate the Trojan origin of the Welsh. A similar custom, Mr. Tate says, was continued even in a recent period, by the herdsmen on the grassy plains of Burgh and Rockliff Marshes, in Cumberland; but from the description of these figures, he conjectures that they were serpentine and spiral, like the sculptures at New Grange and in Brittany. We perfectly recollect the Troy town, as it was a common amusement to draw it on slates in our school-boy days, on the borders of Wales, but among the pure English stock on this side the border; and they certainly were not the spirals Mr. Tate supposes, but resembled rather closely some of these sculptures on the rocks. Moreover, we, as boys, had a very widely-prevailing practice of drawing groups of concentric circles, for a game, or rather a trick, which produced just such groups with lines from the centres, sometimes joining two centres, exactly in the same manner as these concentric circles represented on the rocks. We have seen the slate of a boy, who happened not to have at hand a sponge to rub out one group before he made another, covered with them, and presenting an exact counterpart of the groups of sculptures on the Northumbrian rocks. We confess that we feel some difficulty in accepting the extreme antiquity of these sculptures, and still more the notion of their being of a religious or symbolical character. We may add that Professor Simpson, of Edinburgh, has contributed to the new volume (vol. 5, new series) of the *Transactions of the Historic Society of Lancashire and Cheshire*, a short paper on sculpture of a similar character, found on the CALDER STONES, near Liverpool, in which he takes a similar view of their antiquity, but is unwilling to venture an opinion as to their purpose.

The same volume of the *Transactions of the Historic Society* contains a rather elaborate paper on the BONE CAVES OF CRAVEN, and their contents, by a well-known and meritorious antiquary, Mr. Ecroyd Smith. These caves, chiefly found at Settle and Arncliffe, contain human bones, with the bones of numerous animals, two or three of which belong to species now extinct in our island, and a considerable number of objects of human manufacture, such as coins, fibulæ, etc. By far the greater portion of these are undoubtedly Roman, and belong to a late period of the Roman occupation of our island, while the other objects are merely of ruder materials and ruder workmanship, and present no characteristics which

would fix their date independently of the other objects with which they are found. Under these circumstances, we think we are justified in considering that they also belonged to the Roman period, for there must have been a class of the population in a ruder state, and with ruder manufacture, than the high class of Romano-Britons. We hold still that the contents of these caves show that the period at which they were occupied by man was the close of our Roman period, when this country must have been in a state of great confusion, and life must have become almost savage. Perhaps the coins and the more ornamental objects of art may be the remains of plunder. Mr. Ecroyd Smith produces some examples of a class of round fibulæ, made of bronze, found in these caves, which he calls "ancient British brooches," and on the extreme antiquity of which he insists. We have always thought that the style of art of these fibulæ is in character debased Roman or Greek—a barbaric style, formed on Roman or Greek models—and it seems to us to belong rather to the very beginning of the middle ages than to the prehistoric period. But we would call Mr. Smith's attention to the fastening pins of these fibulæ, which are so minutely identical in character with the pins of the Roman fibulæ, that we think they are clearly either Roman or imitation of Roman. We cannot leave this volume of the Historic Society's transactions without saying that it contains some excellent papers, and that it is altogether highly creditable to the scientific body which has produced it.

The opinion of recent antiquaries, that Old Malton, in Yorkshire, occupies the site of the ROMAN TOWN OF DERVENTIO, seems to be fully confirmed by recent discoveries made at Norton, a parish separated from Old Malton by the river Derwent. These excavations have brought to light numerous objects of Roman manufacture which appear to show that a principal cemetery of the Roman town occupied this site. T. W.

LITERARY NOTICES.

THE GARDEN ORACLE AND FLORICULTURAL YEAR-BOOK, 1867. Edited by SHIRLEY HIBBERD, F.R.H.S., Author of "Rustic Adornments for Homes of Taste," "Brambles and Bay Leaves," "Essays on Things Homely and Beautiful," "The Town Garden," etc., etc., and Editor of the "Gardener's Magazine" and "Floral World." (Groombridge and Sons.)—This is a remarkably useful book, and from its very small price, no one with a piece of garden need be without it. It commences with a series of tables especially useful for gardening operations, such as seed-sowing, planting, draining, application of manure, the contents of vessels used in horticulture, etc., etc. Then we have an interleaved almanac, with notes on the cultivation of divers fruits, and the names of sorts best adapted to different situations. Then comes a "Calendar of Garden Work," followed by interesting and valuable notes on the "New Plants of

1866" (many of which seem well worth attention), "New Ferns," and "New Flowers," add to our information on these subjects; and the whole winds up with an interesting chapter on "Odds and Ends." Mr. Shirley Hibberd is unrivalled in labours of this kind.

AN ESSAY ON DEW, AND SEVERAL APPEARANCES CONNECTED WITH IT. By WILLIAM CHARLES WELLS. Edited, with Annotations, by L. P. CASELLA, F.R.A.S., and an Appendix by R. STRACHAN, F.M.S. (Longmans.)—Dr. Wells's Essay on Dew has acquired a fresh interest, not only from recent discoveries, but also from the reference made to it in a popular work of Professor Tyndall, and as the original editions have been long out of print and copies very scarce, M. Casella deserves the thanks of scientific students for having reprinted it in a handsome form, and with valuable additions. Dr. Wells's statement of his experiments, and his exposition of the views to which they led are remarkably interesting, and few scientific works will better repay perusal.

ANIMAL MAGNETISM AND MAGNETIC LUCID SOMNAMBULISM. With Observations and Illustrative Instances of Analogous Phenomena occurring spontaneously, and an Appendix of Corroborative and Correlative Observations and Facts. By EDWIN LEE, M.D., Etc. (Longmans.)—This work is an epitome of stories and evidence pertaining to the so-called subject of "animal magnetism" and somnambulism. It is not what we should call a scientific work, as it does not exhibit the application of any powers of analysis, or of those prudent philosophic doubts with which phenomena should be scrutinized, and their interpretation attempted. That mesmerism and its associated subjects are really worth profound study we feel assured, but as a rule, these matters are neglected by good experimentalists and acute thinkers; and we have on the one hand a vast quantity of marvellous assertions resulting from credulity, and on the other a more comprehensive denial than an extended collocation of facts would warrant. As matters intimately connected with nervous physiology, we should gladly see the facts of mesmerism and spirit-rapping separated from the fancies, delusions, and frauds which constitute no small portion of the records with which the public have become familiar. We fear Dr. Lee will not effectually assist in such a movement as he seems to us prone to premature belief.

THE ELEMENTS; an Investigation of the Forces which determine the Position and Movements of the Ocean and Atmosphere. By WILLIAM LEIGHTON JORDAN. Vol. I. and II. (Longmans.)—The author believes in what he calls "astral gravitation," which he conceives to counteract the attraction of the sun and moon upon the waters of the globe and upon its atmosphere. To this "astral attraction" he ascribes the tides in parts of the earth opposite to the sun and moon. We do not understand the writer's line of argument. He talks of the action of gravitation as tending to convert the universe into a motionless mass, but a "force of evanescence" is brought into play, and saves it from such a result, and we are further told that "evanescence implies a motion of evanishing particles," and that contraction is a necessary consequence of it.

NOTES AND MEMORANDA.

Food of the Heron.—T. Y. Greet, Esq., of Morris Hall (near Edinburgh), writes: "On the 7th instant my keeper shot a young heron. To-day, on being prepared for table, it was found to contain two redwing thrushes and a water-wagtail; one of the former was in a most perfect condition, hardly a feather removed. Is such a thing usual in the heron's habit of feeding?" [In Morris's *British Birds* the heron is described as omnivorous, and, amongst other things, is said to eat the young of other birds. Ed.]

Gauging the Light of Spots on the Moon, and Checking Additions.—The Rev. N. J. Heineken writes: "It has occurred to me, in connection with the supposed altered brilliancy of the spot 'Linné' in the moon, that it might from time to time be tested by comparison with some other *fixed* place in the moon. This might possibly be done by a shade of thin metal over a portion of the diaphragm of the eye-piece, which shade should be pierced with a very fine hole, the light admitted through which could be at any period reduced to the same intensity as that exhibited by the spot under examination, by shades, or a wedge of ground glass, or other means. The comparison could thus be always made with ONE TEST spot. The plan in fact is not unlike the lamp micrometer of the elder Herschel. In a former letter I mentioned to you the application of Perkins's pedometer to the counting of meteors, and I have lately found it very useful as a check upon the tedious and often uncertain process of addition. For instance, in ascertaining the result of meteorological observations, the string is pulled for each unit in a column, the tens carried to the next, the same written down and divided by the days as usual to obtain the means. This I have found a *complete* check upon previous *ordinary* addition. If the above suggestions appear of any value, pray make use of them as you think fit. The plan proposed for observations on the moon I have lately tried *myself* with a prospect of success."

Mr. Rutherford's Celestial Photography.—Dr. Gould, writing in *Astronomische Nachrichten*, states that Mr. Rutherford, with a photographic object-glass of 11¼ inches aperture, has carried his process to such perfection that he readily obtains impressions of stars 8½ mag., provided they are not red. It is easy to obtain the image of a region one degree square.

An Angle Measurer, by Thomas D. Smeaton. In vol. viii., p. 197, our readers will find "A New Angle Measurer" described by N. J. Heineken. This paper attracted the attention of Mr. Thomas D. Smeaton, of Robe, South Australia, who proposes a modification, which he thinks an amateur might easily construct. He dispenses with the tube shown in Mr. Heineken's drawing, and makes the wheel of hard wood three inches in diameter and one inch thick. This is weighted by driving a bullet in a hole at the place where Mr. Heineken puts a weight, and an exact counterpoise is obtained by forcing shot into small holes at the back of the instrument. The wooden wheel has flanges quarter of an inch high, and in its concavity he fastens a slip of paper graduated from 0 to 90 upwards, and from 0 to 90 downwards, leaving a space between the zeros equal to the thickness of the suspending wire. "To use the instrument, hold it between the object and the eye, so as to make the wire cover the object; the wire will then cut the graduated flange at the angle of altitude, using the upper and lower edges of the wire for the corresponding gradients. Similarly the shadow of the wire will give the sun's altitude." Let us take this opportunity of thanking Mr. Smeaton for sending us some beautiful Australian compound polyps and polyzoa.

Simultaneous Concealment of Jupiter's Satellites.—The *Monthly Notices* contain an announcement by Mr. Airy of the approaching and rare phenomena of the simultaneous concealment of Jupiter's four satellites. He says, "On Aug. 21, Jupiter will be without satellites for one hour and three quarters." At 8h. 14m. the third satellite will enter on Jupiter's face; at 9h. 9m. the second will be eclipsed; 9h. 28m. the fourth will enter on Jupiter's face; 10h. 4m. the first will enter on Jupiter's face. Times of reappearance respectively 11h. 49m., 12h. 13m., 12h. 23m., 13h. 54m.

Acoustic Figures.—*Cosmos* describes the following method adopted by M. Kundt. In a tube about a yard long and a third of an inch in diameter, pour a little lycopodium powder, and shake the tube so as to distribute it equally all

over its interior. Then make the tube vibrate longitudinally, which may be done by rubbing one end with a moist cloth, and the powder will unite at certain points, exhibiting the spiral nodes of Savart. If, after the lycopodium is applied, the tube is closed at both ends, and fixed by one or two bands (*nœuds*), the powder does not assemble at the spiral nodes, but assumes a peculiar arrangement at the bottom of the tube. Periodical accumulations are remarked, composed of a series of transverse layers, separated by vacant spaces. By filling the tube with different gases, the length of the waves exhibited by the lycopodium will be found to vary in proportion to the velocities with which they conduct sound.

Petroleum in Sicily.—Seven springs are said to have been discovered in Sicily, which it is intended to work.

Friction of Celestial Bodies and Ether.—M. de Fonvielle has a curious paper in *Cosmos* on this subject. The atmospheres of rotating bodies like the sun or planets must exert a friction on the ether of those surrounding them. The friction of the sun's atmosphere against this ether he estimates at thirty times that of our earth, and says, "other things being equal, the bigger a celestial body, the more the temperature of its surface will be raised by friction against the matter in space, and the greater the probability that this matter will be the seat of energetic reactions and combinations with the rotating bodies' atmosphere."

A Spontaneous Generation Experiment.—M. Donné states, *Comptes Rendus* (Jan., 1867), that he makes a small hole in an egg with an awl, previously made red hot. He pours out about a third of the egg's contents, fills it up with boiling distilled water, closes the aperture with wax, and keeps the egg in his room at a temperature of 17° to 24° C. In five days he finds the egg-matter swarming with vibrions.

Eyes of Caterpillars.—M. Hermann Landois states that all kinds of caterpillars possess six eyes on each side of their heads, immediately below the articulation of the mandibles. The cornea he finds to be divided in three segments, each exhibiting its proper curvature. Below the chitinous stratum of each cornea he observes a sphereoidal chrystalline lens, formed of striated and uncleated fibres concentrically arranged, and below these lenses he notices a diaphragm or iris composed of about thirty-five contractile fibres, and below the iris what is known as a "crystalline body," which seems to consist of terminal optical fibres. He regards these caterpillar eyes as intermediate between simple, and compound facetted, eyes, and proposes to call them "compound ocelli."—*Zeitschrift fur Zoologie.—Archives des Sciences.*

Molecular Force in Liquids.—M. G. Van des Mensbrugghe referring to some experiments of M. F. Platenu states that if a vessel, about ten centimetres wide, is three parts filled with water, held in front of an open window at least six metres from the ground, and suddenly acted upon by a lateral shock, the fluid in falling will form bubbles, the biggest of which are generally five or six centimetres in diameter. He tried various liquids: the bubbles of alcohol soon break, fatty oils do not, from their viscosity, give a thin sheet, and their bubbles are small. In other experiments he places a globule of mercury about half a millimetre in diameter on the blade of a knife, and gradually, by immersing the knife, brings the mercury in contact with the surface of the water, on which it will float and exhibit the phepomena of capillarity. The depression of the concave meniscus is found to be very large in proportion to the size of the globule. The attraction of floating bodies for each other may be shown by floating several of these mercury globules.—*Pagg. Ann. Archives des Sciences.*

The Planet Mars.—The remarks in the fourth paragraph of my paper on Mars apply to Figs. 1 and 2, as originally drawn. The artist having reduced the scale by one-half, *one-sixteenth* of an inch corresponds to 4,000,000 miles. The reduction has been faithfully effected, save that, in Fig. 2, the short lines surmounted by arrow-heads have been left unreduced. I need scarcely say that I should have thrown the two figures into one, had I adopted the reduced scale. In the smaller globe of Fig. 3, the lower cusp of the shaded part should fall as much to the right of the line $m\,m'$ as the upper cusp falls to the left. It will be seen that the curve of the inner boundary would bring the cusp to the place mentioned, but that this curve has been slightly deviated from, close to the lower cusp.

R. A. Proctor.

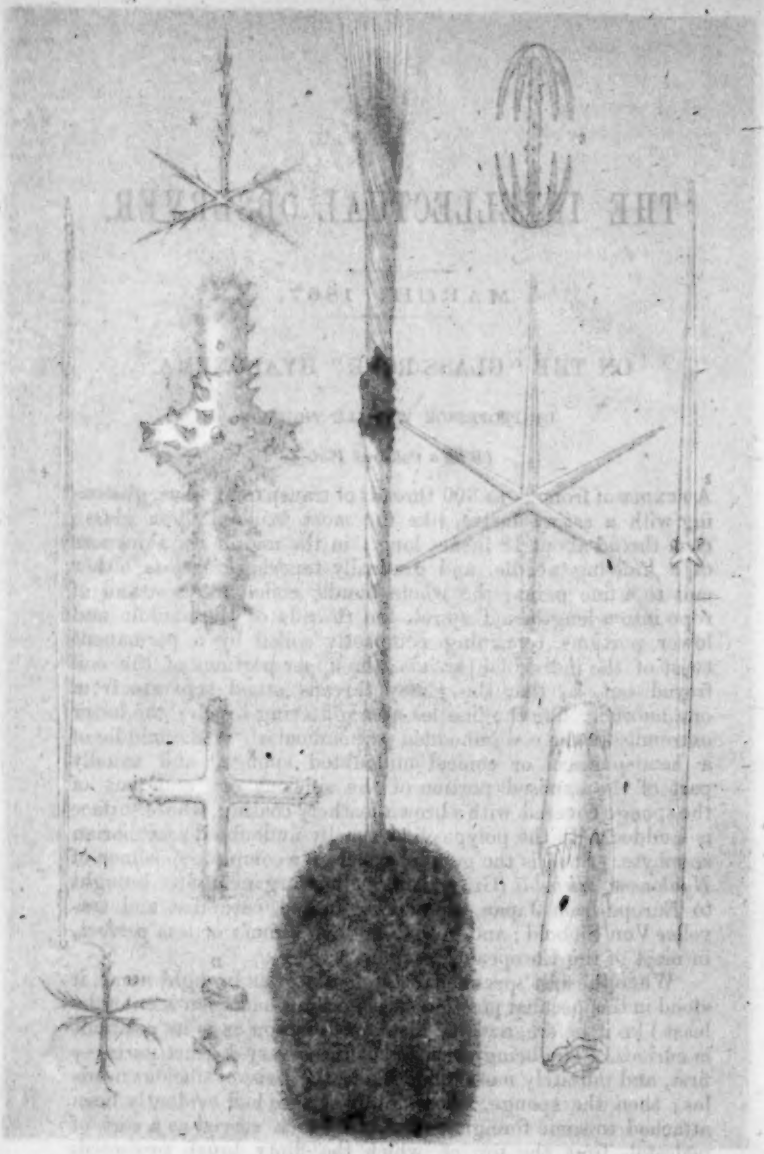


Fig. 1. natural size.
Fig. 2. magnified 90-100 diameters.
Figs. 3, 4, 5, about 150 diameters.
Figs. 6, 7, 8, about 75 diameters.